POWER

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Help Restore Prosperity

IN CURRENT REVIEWS of economic conditions it is not uncommon for the writer to conclude an encouraging statement of increased volume with the admission that on account of reduced prices the net effect was not so favorable.

One of the phases of the present abnormal condition that is watched with the greatest apprehension is the continued lowering of values, the failure of prices to recover.

We had an orgy of spending when more than the usual number of people thought that they had more than the usual amount of money. They are giving more attention now to the relations of price to intrinsic worth and the consequent deflation is not through hurting.

But this is no reason that commodities that were fairly priced before the slump should be offered now at figures at which they cannot be produced at a profit.

If they can be made more cheaply by improved processes, by increased efficiency, by cutting down some of the unconscionable and dispensable items of the unproductive pay roll so let it be. It ought to have been before.

But to cut the selling price of products below that which will maintain a stable, healthy, reasonably profitable business means little present advantage and plenty of future trouble.

Some industrialists, at first appreciative of the coil effect of wage reduction in reduced purchasing power, now see in a reduced cost of living an excuse for a lower wage.

Another regrettable effect of the prevalent sense of impecuniosity is the manifest disposition to buy inferior apparatus and merchandise and to buy as little as will serve the present purpose. If the better grade is ever worth its price why is it not now? Perhaps the hand - to - mouth practice will change when the market becomes a rising rather than a falling one.

Collective practice of buyers and sellers in these respects will have its effect upon the return of prosperity to the individuals who make it up.

Another thing that helps to perpetuate the gloom is the slowness of collections. Previous depressions have brought out crops of stores, of payment movements once started clearing up group indebtedness with the passing of little or no money. Perhaps an extra effort to pay up now will come back with unexpected benefit.

And then there is that "surplus" or "reserve" into which profits of abundant years are slid with the explanation that they are to even out the deficiencies of years less profitable. Is this one of the occasions for which such excess profits are claimed to be justified? If so is it time to do some evening?

F. R. Low

EDITORIALS

Neglected Possibilities in Industrial Power

POWER! What a dramatic word that is! From all sides come evidences of its gripping influence in the life and being of civilization. The harnessing of water falls, the conversion of the stored energy of coal, petroleum and natural gas, the utilization of the sun and tides, offer never-ending opportunities to intrigue the imaginations of forward-looking power engineers, industrial executives and thinking people everywhere.

Speaking broadly, there can be no doubt that the world is power-minded.

Yet, in the very midst of it, where technical men are busily engaged in daily demonstrating the value of their training in other directions, there are flagrant examples of neglect and utter disregard of the first principles of modern power production.

Industries which are highly developed in the technique necessary to build or fabricate their product are the most likely to regard power as a useful but insignificant adjunct to the product it makes. There are many cases where a step from the thoroughly up-to-date shop or factory into the power house is like going from the sublime to the ridiculous.

Old boilers, any old kind of coal and seldom twice the same, pumps that somehow wheeze along weeping copiously from neglected stuffing boxes, maverick engines of untraceable ancestry, all bear testimony of escaping dollars. And to complete the circle, plants of this sort are usually manned with operators temperamentally equipped to be satisfied with their jobs or who philosophically accept the boss's lack of understanding as a part of the price they must pay to avoid being fired.

It may be argued that the power cost per finished unit of factory output is so small as not to warrant attention to the power plant. But how can this attitude be justified if there is any opportunity whatever for saving dollars by the use of more efficient equipment?

If there is reason for any industry operating a power plant at all, there is reason to make the power as cheaply as it can be produced with properly engineered modern equipment.

Predicting Water Supply For Hydro Plants

IF SOME positive method could be devised to predict the water supply for hydro plants great benefit would result. Water supply is subject to nature's caprices. In wet seasons a hydro plant's operation may be handicapped because of too much water and in dry seasons because of too little water.

Reservoirs for seasonal storage have sometimes proved a false security in that the stored water has been insufficient to meet demands over protracted droughts. These water shortages have emphasized the need for accurate means of predicting, years in advance, the amount of precipitation that may be expected over a given drainage area.

The growing importance of this problem is directing increased attention to the rainfall cycle. Studies of the sunspot cycle and ring growths of trees have indicated possible means for determining expected rainfall over a period of years. In certain localities these methods have been fairly successful; in others conformity between actual precipitation and forecasts has been lacking.

Because these methods have failed in some instances is not sufficient reason for condemning them generally. The theory may be correct, but our knowledge of applying it may be lacking in some important fundamentals that further research will reveal. Until some new and better way is found for long-range prediction of precipitation, present methods should be followed and further perfected.

Mud-Drum Head Inspection

NEARLY two decades ago an epidemic of water-tube boiler explosions, caused by failure of drum heads at the heel of the flange, led to a revision of the A.S.M.E. Boiler Code that called for heads of greater radius and construction generally that would tend to stiffen the head at its weakest point. Many

of these failures had originated in the heads of mud drums that were incased in the masonry of the settings. Accumulations of soot and ash between the brick and metal, with moisture absorbed during the turbining or cleaning periods, set up external corrosion. With no way to inspect these heads except by removal of the brickwork, this external corrosion in many cases continued undetected up to the point of rupture.

Even before the stronger head made its appearance, cast-iron division plates, steel plates reinforced with angles or tees, or plates slipped into grooves formed by channels, were available to place in the furnace wall of a battery to separate the drums of adjacent boilers and leave the heads accessible for inspection.

Notwithstanding their availability, these means of facilitating inspection were not generally adopted. Boilers not so equipped were allowed to remain in their original state, and new settings were built that omitted these appurtenances. So that today there are many boilers without this simple means for making inspection easy.

Detection of initial deterioration and minute flaws that may lead to serious consequences is not easy at best. Every facility should be provided to help the inspector in his work, for more exacting inspection reflects to the advantage of the owner, the boiler-room employees, the insurance companies, and all concerned.

As pointed out in recent educational campaigns by insurers of boilers, it is a simple matter to expose the drum head for inspection as outlined.

Proper Motor Applications Cut Power Cost

TOO FREQUENTLY motors are selected as something to drive a machine and without sufficient attention to their influence on plant operation and power cost. In the present rate systems, power factor and maximum demand are important elements. By limiting the heaviest power demand to off-peak periods it is possible to further hold down power costs. To take full advantage of these and other expedients for reducing power costs, they must be carefully studied and be given proper weight when deciding on the size and type of application for equipment to be selected.

Large savings are being made in many plants by controlling the maximum demand. In one plant a simple change in scheduling processes saved a thousand dollars per month in power cost, chiefly through control of the maximum demand charge. Although it is frequently possible to plan the reduction of the maximum demand in existing systems, such studies should be included in the original design.

Control of power factor in most systems is a serious problem, and it is frequently aggravated because the power system "just happened" and was not developed on sound engineering facts. Using oversized induction motors, selecting induction motors for drives where synchronous motors can be used advantageously, applying slow-speed induction motors instead of high-speed motors and speed reducers—these are some of the causes of low power factor.

It is not always possible to obtain the desired power factor by motor selection, but there are many low-power-factor installations which could have been avoided by correct motoring. If the system's power factor is going to be low, it should be known when the design is being made. It is then that necessary corrective means should be provided at minimum cost. Some capacity in one or more synchronous motors may be all that is required to avoid a penalty in the power rate. On the other hand, a high power factor requires less capacity in equipment and lines to supply a given load.

Cramping the Style Of Good Equipment

IN AN IDEAL WORLD, the seller would insist on proper engineering application of his equipment. But as a practical matter, under stress of keen competitive conditions, the buyer unwittingly compels the maker of equipment to furnish what he (the buyer) wants most—low first cost and a generous guarantee. The result is stokers or pulverizers that are too small, furnaces that are inadequate, disputes about guaranteed performance and, finally, coal-buying limitations that impose a continuing penalty on the market, which, if capitalized, would exceed the whole cost of the equipment."

This significant paragraph is quoted from the last article—appearing this week—of the series "Buying Coal for Profit," by G. B. Gould.

The great fault lies with the user who forgets he is buying service and not merely a piece of good equipment. "Is this make of pulverizer and stoker A1?" he asks in effect. He finds that it is. The next question is "How much will it cost to get one to go under this boiler and to deliver a certain output with a given efficiency?"

Now it is a fact that the effective capacity of stokers, pulverizers, and other fuel-burning equipment, depends not only upon the size, but also on the grade of coal used. If the buyer insists on getting a good piece of equipment at the lowest cost, it can be given to him, providing guarantees are limited to special grades of fuel.

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POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

Gas and Oil Supplement Sawdust Fuel at Murray Body Plant

Fig. 1—Murray Wood Products Company plant at Memphis

Modern 3,000-kw. plant obtains cheap power as a byproduct from steam for kiln drying and heating. Use of waste fuel, supplemented by natural gas and oil, a factor in the low cost. Sawdust handling and burning is efficient. Location and sizing of air supply ports in furnace wall prove important

OWING to the availability of the right kind of wood and the favorable labor situation in the South, the Murray Corporation of America, some two years ago transferred its wood working operations to Memphis, Tenn., where the Murray Wood Products Company had just completed a large wood-working plant. Here all of the wood parts for Murray automobile bodies are made, then crated and shipped to the main works at Detroit for assembly.

Waste Fuel and Byproduct Power

With an abundance of waste fuel available in the form of sawdust and hogged trimmings and the need of steam for kiln drying of the lumber, it was decided to take advantage of the cheap power that would be available as a byproduct. A complete power plant, therefore, was built, consisting of three 7,500-sq.ft. water tube boilers of the four-drum bent-tube type and three 1,000-kw. back-pressure turbine-generators. Space was left for two additional boilers and electric generating capacity to provide for the anticipated duplication of the initial works.

Steam is supplied to the turbine throttle at a pressure of 275 lb. and superheat of 100 deg. F. The back pressure is 15 lb. All exhaust steam from the main generating units, as well as that from the steam-driven auxiliaries, including turbine-driven boiler-feed pumps, engine-driven forced-draft fans and steam-driven air compressors, is discharged into a common main leading to the feed-water heater and the kilns. For much the greater part of the year, a practical balance is maintained between the exhaust steam supply and the steam demand.

Condensate from the kilns and the heating system is collected in receivers and pumped back to surge tanks in the boiler room, and then through a vent condenser into the open feed-water heater. Make-up is drawn from the cooling water circulated through air-compressor jackets and the generator air coolers, as it is at a higher temperature than the city supply. It is admitted under float control to the surge tanks.

As the load has developed, two of the boilers and two of the three generating units have met all demands. At 50 per cent overload one boiler carries a turbine, the latter requiring at full load 31.4 lb. of steam per kilowatt-hour. Three-phase 60-cycle current generated at 4,100 volts is conducted to a transformer station in the manufacturing plant, where it is reduced to 440 volts for service, or to motor-generator sets that have been provided to supply direct current for operations requiring variable speed.

For the satisfactory burning of the wood refuse a

furnace volume of 6,400 cu.ft. has been provided under a boiler containing 7,500 sq.ft. of surface, a ratio of 0.85 to 1. This is about the requirement for good pulverized coal practice and double the volume that would be required in a stoker-fired furnace. Gas passages in the boiler and breeching areas are considerably larger than for coal burning, the free breeching area in the present case being 0.053 sq.ft. per square foot of heating surface, as compared to 0.035 for coal burning.

Furnace Construction

In the construction of the furnace use has been made of the Detrick sectional supported wall, made up of 9-in. refractory blocks, a 9-in. air space, and 4½ in. of salt glazed brick as the exterior casing. As an expedient to keep down the temperature of the blocks, the side walls have natural ventilation, the air entering through a belt of checkerwork at the bottom and passing out into the boiler room through similar checkerwork at the top. Preheat is obtained by passing the air through the 9-in. space in the front wall and the 12-in. space under the furnace floor. Ducts in the floor lead to the suction of the forced-draft fan. The air is admitted through checkerwork at the top of the front wall and with operation at 250 per cent rating is delivered to the fan at approximating 165 deg.F. Near the center of the front-wall height four tempering dampers adjustable by hand are provided to control the quantity and temperature of the air.

The Draft Problem in Burning Sawdust

Two fans, each of 54,000 c.f.m. capacity and engine driven through a Texrope drive, are installed to care for the ultimate boiler capacity. They discharge to a common duct passing behind the boilers from which a dampered branch duct leads to each side of a boiler setting, as indicated in Fig. 6. Each branch duct has five dampered connections to as many compartments at the bottom of the air space in the wall, and from each compartment two 2½- x 4½-in. ports give access to the interior of the furnace. The damper in the branch duct controls the quantity of air and the dampers in the five connecting flues regulate the supply along the length of the furnace. Pressures up to ¾ in. of water at the fan discharge and 0.1 in. at the furnace have been found adequate.

Subsequent operation emphasized the importance of locating the ports in line with the furnace floor. Initially, larger ports had been arranged 12 in. above the floor. Sawdust that did not burn in suspension would pile up on the furnace floor. Below the ports it would not burn, and with low air velocity from the

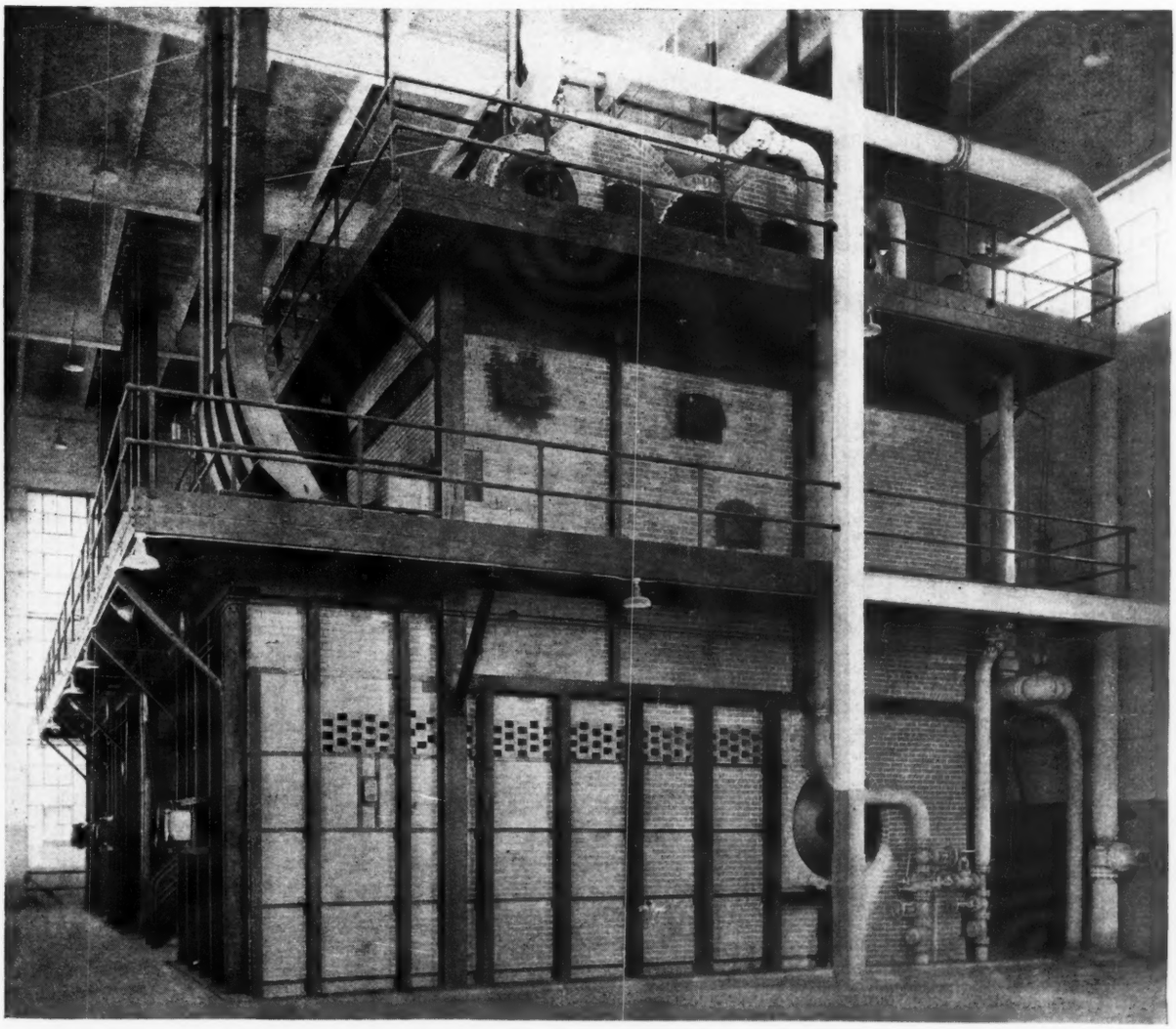

Fig. 2—Boiler plant designed for the burning of wood refuse

large ports, there was not sufficient turbulence to keep the material from building up at the center of the furnace, where it simply charred on the outer surfaces of the pile.

To stir up this unburned material the use of steam was considered, but, before adopting it, a solution of the problem was found in lowering the ports and in reducing their size, so that air at proper velocity could sweep along the bottom of the furnace, stir up the sawdust on the floor, and by intermixing fuel and air in the required proportions, cause the fuel to burn with entire satisfaction. Apparently the ash is too light to remain in the furnace, but once every two months about 1½ cu.yd. of hard clinker is scraped from the furnace floor.

Handling Sawdust to the Burners

Tracing the sawdust from manufacturing plant to boiler furnace and outlining the provisions for use of stand-by fuel, including both natural gas and oil, will complete the essential details. From a central collecting system in the manufacturing plant, blowers deliver the sawdust to cyclones on the roof. From these collecting

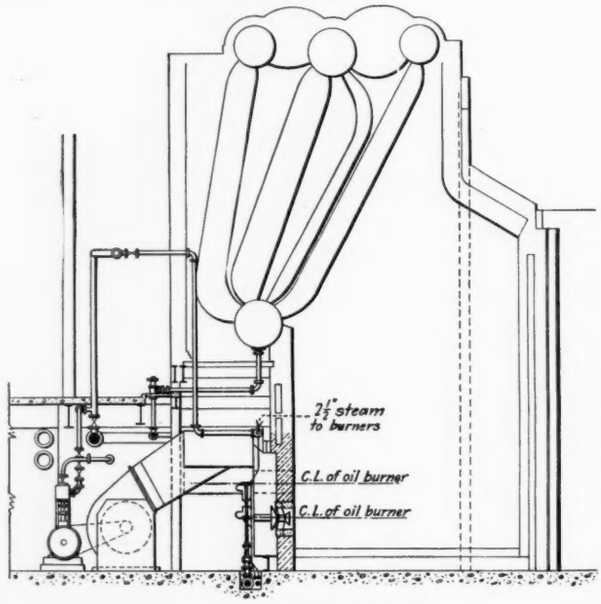

Fig. 3—Gas and oil burners mounted on rear of bridge wall for use when sawdust supply is inadequate

points an additional blower transfers the material to a cyclone delivering through a V-discharge into either one of two storage silos located beside the boiler house. Agitators in the form of a bank of screw conveyors at the bottom of each silo keep the sawdust from packing and give a steady feed to the motor-driven blower unit underneath. Each of these blowers delivers

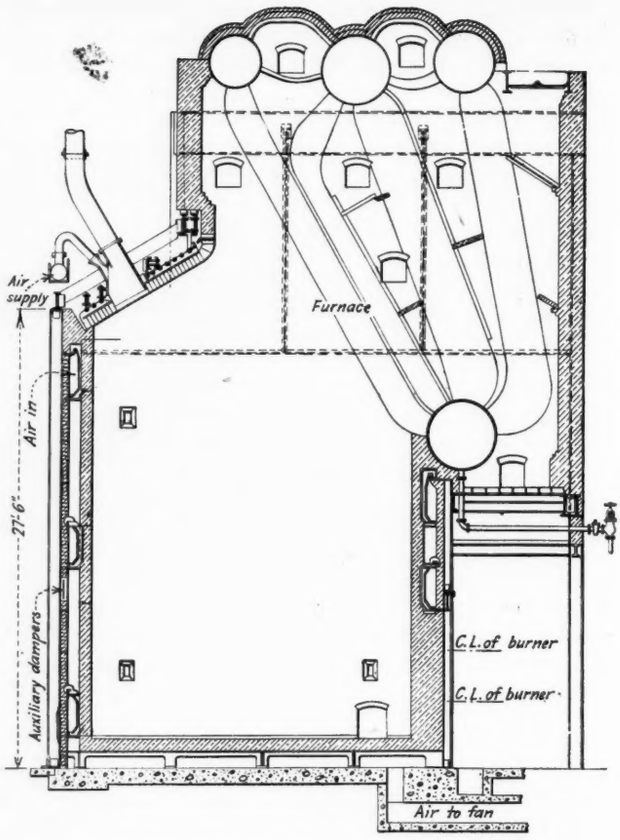

Fig. 5—Section through boiler setting equipped to burn sawdust, gas or oil

to collecting cyclones over steel-plate storage bunkers on the roof, one for each boiler.

At the bottom each bunker is hoppered for four delivery outlets and is equipped with sawdust stokers. Outside hoppers have three screw conveyors and central hoppers two, arranged on an incline so that one feeds the other. They agitate the sawdust, keep it loose and free from packing, and eventually deliver it through an outlet near the end of the hopper into a single short-screw feeder discharging into the down-spout leading to the burner.

Four burners per boiler are supported on the arch steel at the top of the furnace. Attached to a 12-in. supply pipe, each burner is flared in one direction and tapered in the other to outlet dimensions of 7 x 24 in., and is fitted with air and steam nozzles to provide turbulence. Finding the air pressure too low for this purpose, the steam was introduced at the burner, but it was found later that better results could be obtained by introducing the steam higher up in the supply pipe, where it could break up the chunks into which the sawdust may form and prevent the fire from creeping

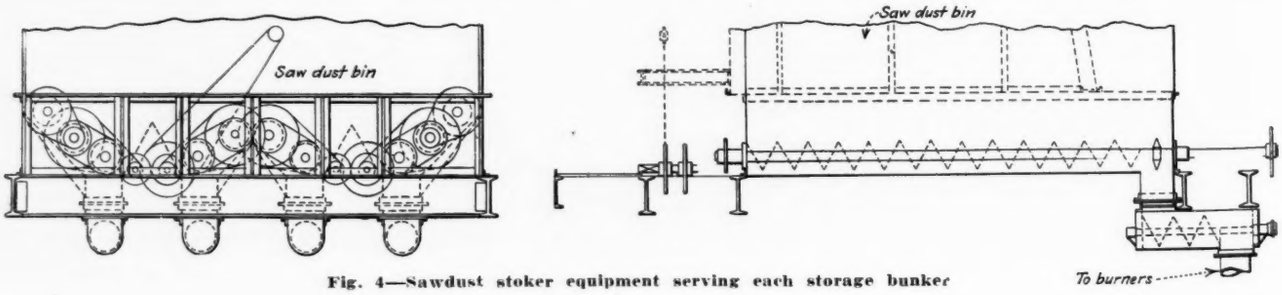

Fig. 4—Sawdust stoker equipment serving each storage bunker

up the feed pipe, which it tended to do regardless of the check valve.

Rate of feed is controlled by the speed of the conveyors forming the sawdust stoker. They are driven by constant-speed motors, with infinitely variable speed reducers interposed, the handwheel control being reg-

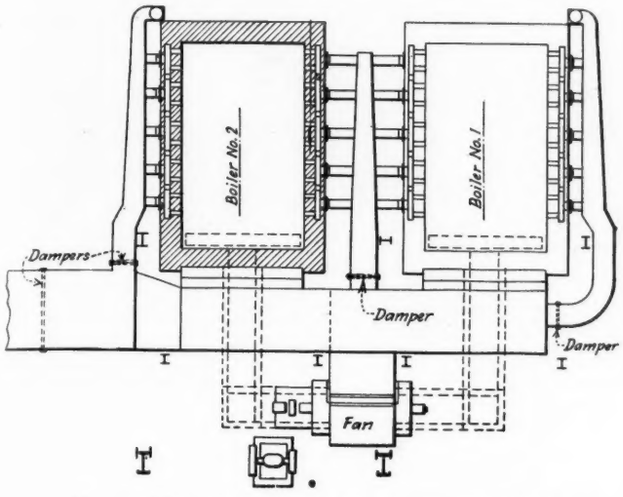

Fig. 4—Duct system supplying air for combustion

ulated by continuous chains dropping to the boiler-room floor. From the same location the motors are under push-button control.

Gas and Oil for Emergency Use

To provide for emergencies that might carry past the eight-hour storage supply of sawdust, or the necessity of drying lumber during an enforced shutdown of the mill, natural gas and oil were made available as supplementary fuels. Seven combination gas and oil burners per boiler were mounted on the back of the bridge wall. Burners requiring $\frac{3}{4}$-in. air pressure or less were installed in a common wind box supplied from the same fans used for sawdust burning. The wind box is dampered so that light loads may be carried on natural draft. Between supply pipe and burner a flexible hose connection permits movement in or out of the adjusting valve controlling the length of the flame.

Owing to the auxiliary nature of the oil as fuel, and the possible requirement of oil for only a few hours at most, no storage is provided. The oil is drawn directly from tank cars, which are available at any time, by duplex steam pumps which force it through heaters using the exhaust of the pumps, to the burners. An accompanying illustration shows the general arrangement of this supplementary fuel installation.

Details for this story were obtained from Albert Kahn, Inc., engineers and architects of Detroit, who designed and supervised the construction of the plant.

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Ten members of the mechanical maintenance crew at the Rio Grande Power Station of the El Paso Electric Company, El Paso, Texas, recently completed 68,660 man-hours without a chargeable accident. The record established means that the men composing the crew have maintained a status of perfect safety in operation during two and a half years. E. O. Woodhouse is foreman of the crew.

Employee Advancement by Stepped Wages or Stepped Jobs

By R. F. SORRELLS

IN PLANNING a schedule of wage advancement for employees there are two general plans which present themselves: In the first plan a definite wage is assigned to each job and the men are advanced from job to job with the corresponding increase in wages called for by the new job. The second plan is to assign no definite wage to each job, letting each man set his own wage by the value of his work to his employer.

Each of these plans has its advantages and disadvantages, and either may be used successfully.

By the first plan every man working at the same job will receive the same wage, and less discontentment will be found here than in the second group. The worker of real value knows that if he will work as he should and show the proper interest, he will advance to a better job paying him more money. The worker coasting along in a rut barely holding his job will be pleased that the man working with him is making no more than he, and there will be less dissension.

A disadvantage of this system is that at a time when a man may be very deserving of an increase there may be no job open directly above him and he must wait until such an opening occurs before he may receive his reward. This disadvantage is overcome in the second plan, for at any time the employer feels that the man is deserving of a reward in some way, he can increase his wage as he thinks fit, even though the job may not be changed.

With this second plan a man may also receive a change in position without a change in wage. His wage is not directly dependent upon his position. Promotion can be considered by the individual as a vote of confidence from his employer and, likewise, an opportunity to better his productive ability, incidently bringing an increase in wage at a later date. However, it is the increase in wage that is considered his reward and not the change in position.

In a large organization where several hundred men are employed it is necessary that some definite plan of advancement be devised. Many companies use one of the two plans without modification, while some use systems made up of the two combined in various ways. For instance, one company allows each man to determine his own wage by his work, but the management also specifies a maximum wage for each job. When the worker has reached the maximum wage for his particular job it is up to him to strive for a promotion to a better job in which he is eligible for a higher wage.

Then too, this same company makes it a practice to consider a man for an increase in wage once each year. Each man's immediate superior is consulted by the superintendent once each year concerning the man's eligibility for an increase in salary. To avoid confusion, the men are divided into three groups and one group is considered each four months. In this manner the matter of raises is given full consideration at minimum effort and loss of time.

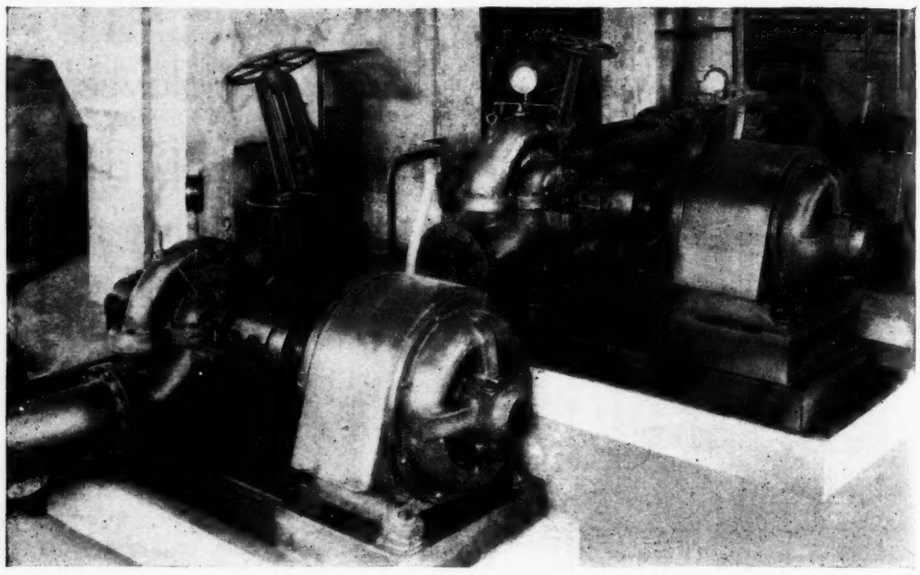

Fig. 1—One 150-hp. and two 200-hp. squirrel-cage motors driving a 500-g.p.m. fire pump and two 6,000-g.p.m. mill-supply pumps

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Selecting the Motor to Suit the Pump

By E. C. DIEFFENBACH
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STARTING CONDITIONS and the nature of various loads determine the motor and control. To choose wisely, both motor and pump characteristics must be understood. Drives for reciprocating, centrifugal, rotary and screw pumps are discussed

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FOUR MAJOR PROBLEMS are encountered when selecting electric pumping equipment, namely, constant discharge against constant head, constant discharge against variable head, variable discharge against constant head and variable discharge against variable head. The first condition allows a motor and pump to be selected so that each may operate at its maximum efficiency. The last three conditions involve one or more variables, which necessitates throttling the pump's discharge or changing the speed, depending on the type of pump.

Assuming that maximum efficiency over the operating range is desired, pump and motor characteristics must be carefully compared, and here the advice of pump and motor manufacturer is of considerable importance.

The class of work governs the pump selection to some extent, for each type excels in its particular field. However, the line of demarcation is not distinct between the several types available. The pumps most commonly used with electric drive are reciprocating, centrifugal, rotary and screw types. Air lifts utilizing compressed air have gained prominence, especially for raising water or oil directly without the use of pumping mechanism other than the air compressor.

Reciprocating pumps are suitable where steady flow is not essential, although the pulsation can be steadied by use of a storage accumulator or air chamber. They are admirably adapted to handle heavy, viscous liquids in small quantities against high heads, and are inherently adapted to low-speed drive. They are not so compact and require a heavier foundation than centrifugal, rotary or screw pumps, and must have provision for bypassing or for pressure release in case of excessive discharge pressure or complete stoppage.

Horsepower varies with the speed at constant pressure and with the pressure at constant speed; where friction head comprises the greater part of the total head, the horsepower decreases more rapidly than the speed, since the friction head decreases approximately as the square of the quantity of liquid pumped.

The horsepower required to drive a pump when the total dynamic head is known may be determined by the formula

$$Hp = \frac{gpm \times H \times S}{3{,}960 \times E}$$

where *gpm* is the pump's capacity in gallons per minute; *H* the total dynamic head in feet; *S* the specific gravity of the liquid pumped; the constant 3,960 is obtained by

dividing 33,000 ft.-lb. per minute, the equivalent of one horsepower, by 8.341, the weight in pounds of one gallon of water; and E is the over-all efficiency of the pump expressed in hundredths. For fresh water the specific gravity is 1 and may be neglected.

As an example, find the horsepower required to drive a 400-g.p.m. pump discharging against a total dynamic head of 140 ft. with an efficiency of 65 per cent.

$$Hp = \frac{400 \times 140}{3{,}960 \times 0.65} = 21.75$$

The total dynamic head on a pump is the vertical distance from the free surface of the source of supply to the free point of discharge plus the head due to the friction of the pipe and fittings plus the entrance and exit losses when the pump is delivering its rated capacity. For a detailed discussion on the head of a pump see *Power*, Nov. 11, 1930, page 758.

Both motor and pump characteristics must be thoroughly understood to select the proper drive. Where constant-speed operation is required, the squirrel-cage induction motor or the synchronous motor may be used. Sometimes, for some constant-speed application, the wound-rotor induction motor must be used on account of starting conditions, power-line requirements or motor size. Adjustable-speed operation requires a wound-rotor induction motor with secondary resistance, a brush-shifting commutator motor or a direct-current motor.

Reciprocating pumps are of slow speed and require speed-reduction gearing or belting, even if the motor is of the slow-speed type. If the pump must be started against full head the starting torque must be great enough to overcome the load. Bypass valves can be used to reduce the load until full speed is reached, cutting down the torque considerably. Varied capacity and pressure require an adjustable speed motor.

The squirrel-cage induction motor is often used for constant-speed operation. This motor is manufactured in a number of types with starting torques to suit various starting conditions. The simplest control is an across-the-line starter, where the initial current inrush is not objectionable because of the power supply. If full-voltage starting is not desirable, an automatic compensator can be used to reduce the voltage by means of an autotransformer. Another type of control utilizes a resistance in series with the motor primary; after a time delay, the resistor is short circuited by a contactor and the motor is connected directly to the line.

Wound-rotor induction motors are frequently used for driving reciprocating pumps. Their inherent characteristics are such that the highest power factor is secured at full load and speed. For the smaller sizes a simple starter is often used, by means of which the power line is connected to the primary or stator winding of the motor with full resistance in the secondary or rotor circuit. The secondary resistor is short circuited and the motor comes up to full speed after a definite time delay.

Large-sized wound-rotor induction motors may be started and brought up to speed by a magnetic type of control. When reduced-speed operation is desired the contactors may be regulated by a master controller.

If the source of power is direct current a compound motor with about 10 per cent series field will be found to operate satisfactorily at constant speed. Control may be accomplished by a disconnecting switch with a hand starter. Adjustable-speed operation requires, in addition, a manual field-regulating rheostat. An automatic panel actuated by a push button, float or pressure switch may be used to take advantage of precise regulation with minimum of attention. Overload and under-voltage protection is usually included on the automatic panel. If the motor is to restart on return of voltage the under-voltage

Fig. 2 (Above)—A 15-hp. 1,800-r.p.m. induction motor driving a clay-mixing pump. The manual-type starting compensator for the motor is shown in the upper left-hand corner

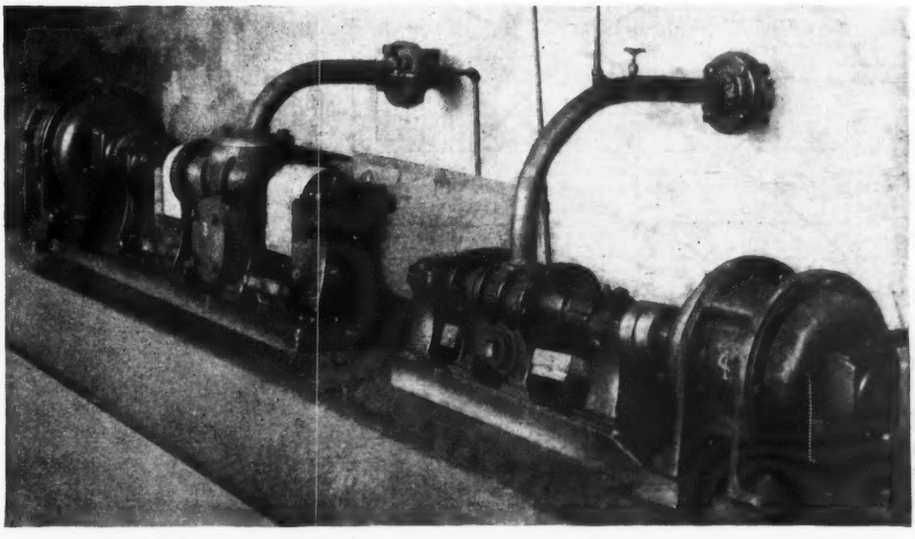


Fig. 3 (Right) — Squirrel-cage induction motors driving screw pumps in an oil refinery. The larger pump is one of four circulators for cracking units and the smaller handles refluxes

release allows the float switch or other device to close the auxiliary circuit.

A scheme for starting synchronous motors on a low-speed reciprocating pump, when full-voltage starting is feasible, uses a full-voltage controller. In the operation of this control the line contactor closes first, connecting the motor directly to the line. Upon reaching about 95 per cent of synchronous speed a field-actuating relay closes its contacts and a field contactor connects excitation to the field coils after a definite time delay and the motor pulls into step. Ordinarily, air-break contactors are suitable when the voltage is low, but for voltages of 2,200 and over, an oil-immersed contactor is necessary. When reduced-voltage starting must be used, various automatic panels are available. In all cases during starting and before the field is applied the field winding is short circuited through a discharge resistor.

Centrifugal pumps are compact, self-contained machines for handling liquids of all kinds. They operate with a minimum of vibration and noise without heavy foundations, and their discharge is steady. Correct design of impeller blades allows of closing the discharge line without excessive pressure or overloading the motor. Practically constant pressure in a closed or an open system is one of their outstanding features. Stopping a pump does not necessitate bypassing it when working as a booster. The centrifugal pump operates at comparatively high speeds and allows direct connection to the electric motor.

Centrifugal pump designs have been improved so that they can pump against high heads. Some of the types include horizontal and vertical units, single- or multiple-stage, for ordinary or for special service. Special service requires that pumps be made of hard lead, acid-resistant bronze, Monel metal or other alloys to handle such liquids or semi-liquids as acids, sulphites, brines, alkalies or melted lead.

Because of characteristics differing from those of the reciprocating pump, the centrifugal pump presents a distinct driving problem. The power for constant total head can be computed as previously explained for reciprocating pumps, but here the similarity ceases.

The power required to drive a centrifugal pump varies as the cube of the speed; the head varies as the square of the speed; the capacity varies directly as the speed; the starting torque rarely exceeds 30 per cent of the full-load torque; and at full speed with the discharge closed the load seldom exceeds 60 per cent of the normal full load, but may equal 100 per cent. Examination of curves supplied by pump manufacturers reveals these points, and they must not be overlooked when applying electric motor drive to centrifugal pumps.

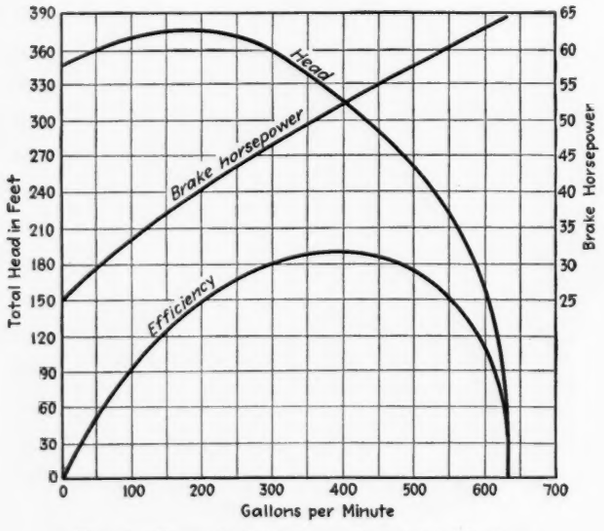


Fig. 4—Characteristic curves for a 5-in. 3-stage, 1,788-r.p.m. centrifugal pump

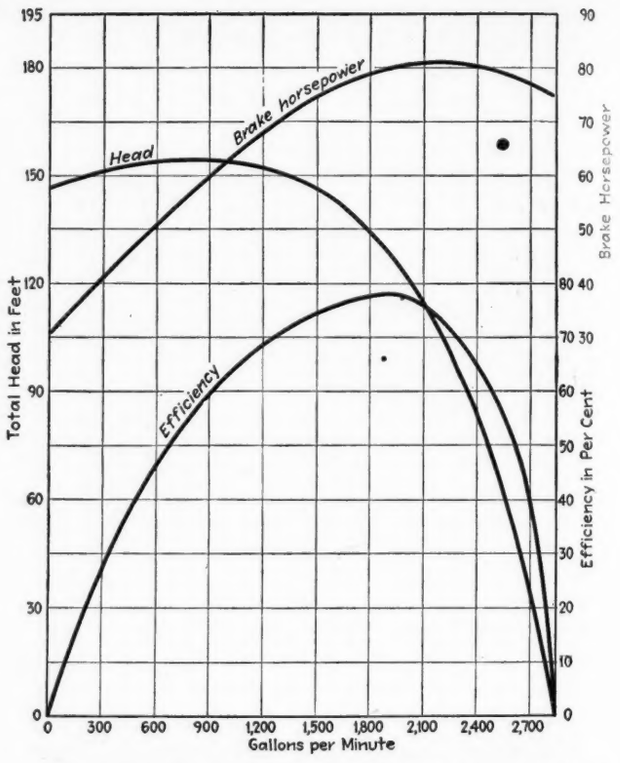


Fig. 5—Characteristic curves of a 10-in. single-stage centrifugal pump operating at a constant speed of 1,200-r.p.m.

Fig. 4 shows the characteristic curves for a pump whose horsepower increases rapidly with a decrease in head. Fig. 5 gives an example of a pump whose horsepower begins to decrease with a decrease in head after the point of maximum efficiency has been passed. In the first case allowance should be made for the pump's characteristics when selecting the driving motor.

Pump speeds have been standardized to conform with the full-load speeds of alternating-current motors. Table I gives the speed corresponding to the number of poles and the frequency. If the pump is not designed for one of these speeds, inefficiency is sure to be the result. Standard rated motors are the best to use with standardized pump speeds to obtain high over-all efficiency for the set.

Two methods are in common use to secure variable discharge or head, throttling of the discharge valve or variable motor speed. The curves shown in Fig. 6 give a comparison of the throttling method compared with adjusting the speed for varying capacity. Curve *A*, for a squirrel-cage constant-speed drive, shows that capacity variation by throttling requires a greater power input to the motor, especially for the lower heads, than capacity variation by speed change of a wound-rotor motor—curve *B*, or by brush-shifting alternating-current motor —curve *C*. Table II gives a tabulation of power inputs at the various capacities and heads.

Breakaway torque for the centrifugal pump is very low and the accelerating torque gradually builds up to full load at full speed. For constant-speed constant-head service, the squirrel-cage motor provides the

simplest drive. Starting torque for the average squirrel-cage motor is on the order of 150 to 200 per cent, depending on the design.

Control for squirrel-cage motors is accomplished by manual or automatic means, which may consist of an across-the-line starter, an automatic compensator or a resistance in series with the motor primary. Voltage and starting current are factors that have a large influence on the type of control selected. Control equipment may be actuated by various means, such as push buttons, float switches or pressure governors.

The wound-rotor motor takes less starting current than the squirrel-cage type, hence it is used for larger drives. It causes a minimum voltage disturbance, which is desirable where the source of power is not large. Manual

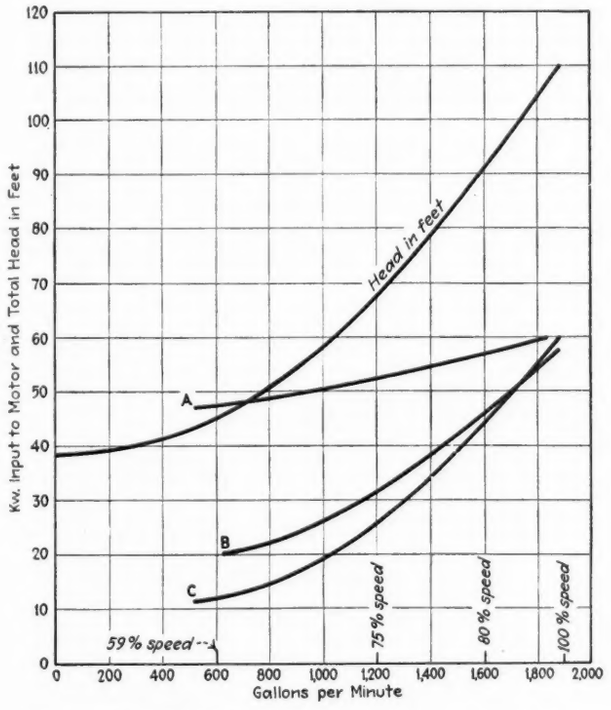


FIG. 6 — THROTTLING VERSUS SPEED CONTROL FOR VARYING THE CAPACITY OF A CENTRIFUGAL PUMP

This pump is driven by a 75-hp. motor having a full-speed of 1,750 r.p.m. Curve *A* shows the kilowatts input to a constant-speed squirrel-cage motor when the pump's discharge is varied by throttling. Curve *B* indicates the kilowatts input to a wound-rotor induction motor and curve *C* gives the kilowatts input to a brush-shifting commutator-type polyphase motor when the pump's discharge is varied by adjusting the motor's speed.

or automatic control, or a combination of both, may be employed. Some speed variation is possible with the wound-rotor induction motor, and Table II illustrates how power input compares with the input to the squirrel-cage and brush-shifting alternating-current motors with the same heads and capacities.

Where direct-current motors are used the compound-wound type with hand starter and disconnecting switch gives satisfactory operation. But control may be a manually operated drum switch or a magnetic panel actuated by a push-button, pressure switch or other device. Speed adjustment may be made by a field rheostat.

The synchronous motor is satisfactory for centrifugal pump drives, particularly for slow-speed, large-capacity units; but their high efficiency and leading power factor make them desirable on high-speed pumps above 25 horsepower.

As discussed for reciprocating pumps, methods of

TABLE I.—SYNCHRONOUS SPEEDS POSSIBLE AT VARIOUS FREQUENCIES*

Poles	60 Cycles	50 Cycles	40 Cycles	25 Cycles
2	3,600	3,000	2,400	1,500
4	1,800	1,500	1,200	750
6	1,200	1,000	800	500
8	900	750	600	375
10	720	600	480	300
12	600	500	400	250
14	514.2	428.6	343	214.3
16	450	375	300	187.5
18	400	333.3	266.6	166.6
20	360	300	240	150
22	327.2	272.7	218.1	136.3
24	300	250	200	125
26	277	230.8	184.5	115.4
28	257.1	214.2	171.5	107.1
30	240	200	160	100
32	225	187.5	150	93.7
34	212	176.5	141.1	88.2
36	200	166.6	133.3	83.3
38	189.5	157.9	126.3	78.9
40	180	150	120	75
42	171.5	142.8	114.2	71.4
44	163.5	136.3	109	.....
46	156.6	130.5	104.3	....
48	150	125	100	....
50	144	120	96	....
52	138.5	115.4	92.3	....
54	133.3	111.1	88.9	....
56	128.6	107.2	85.7	....
58	124.1	103.5	82.8	....
60	120	100	80	....
62	116.1	96.8	77.4	....
64	112.5	93.7	75	....
66	109	90.8	72.7	....
68	105.9	88.2	70.6	....

*The use of synchronous motors is advisable at the slow speeds corresponding to 10 or more poles.

starting synchronous motors vary from full-voltage across-the-line to reduced-voltage starting, the degree of automatic starting attained being limited only by the auxiliary equipment.

Brush-shifting alternating-current motors have been found quite successful for adjustable-speed service. They require some form of line switch with overload protection and a means of shifting the brushes mechanically by a handwheel, shipper rod or a small pilot motor actuated by remote push buttons.

Table II gives some of the advantages of variable-head and variable-capacity operation by varying the speed. The brush-shifting alternating-current motor requires less power at the reduced capacities and heads than the squirrel-cage or wound-rotor induction motors.

Types of rotary pumps probably vary more as to the kind of internal mechanism employed than any other pump. Impellers vary from cylindrical, eccentrically mounted, toothed wheels, annular outside and inside spur gears to many others. Their use varies from the pumping of water to the handling of thick, viscous liquids such as glue, candy stock, syrups, paint, varnish or soap.

Motors and control present problems similar to centrifugal pump drives, with pump action being of the order of high velocity combined with positive displacement.

The screw pump is quiet, vibrationless, compact, has no valves and gives a pulseless discharge. It is used for such service as hydraulic elevators, fire extinguishers,

TABLE II—COMPARISON OF KILOWATTS INPUT TO 75-HP. MOTORS DRIVING A CENTRIFUGAL PUMP 1,750-R.P.M. FULL SPEED

Kind of Motor	Kilowatts Input	Head in Feet	Per Cent Speed-R.p.m.	Capacity G.p.m.
Squirrel-Cage	59.3	110.5	100	1,885
Wound-rotor	59.3	110.5	100	1,885
Brush-shifting	60.0	110.5	100	1,885
Squirrel-cage	53.0	67	100	1,200
Wound-rotor	33.0	67	75	1,200
Brush-shifting	26.0	67	75	1,200
Squirrel-cage	48.0	45	100	600
Wound-rotor	19.0	45	59	600
Brush-shifting	12.5	45	59	600

hot- and cold-water and calcium-brine circulation pumping. Direct drive at comparatively high speeds is the customary method of connection.

Selection of motor and control presents problems similar to centrifugal pump drive and control, permitting a wide variety of manual or automatic regulation.

Mechanical Losses in Two-Cycle Oil Engines

By ALFRED PETTERS

ALTHOUGH the total mechanical loss of an oil engine may be readily ascertained, seldom are data available covering the separate losses. To obtain the information a prominent engine builder ran tests on a 9½x12-in. trunk-piston, crankcase-scavenging, single-cylinder unit direct connected to a calibrated direct-current motor, and obtained the results plotted in the chart.

The full-line curves cover the performance with a compression pressure of 250 lb., while the broken lines give the results when the compression was raised to 500 lb. Since the friction losses of the crankshaft and piston and the power absorbed by the scavenging process are the same with both compressions, they are shown in full lines only.

The engine was assembled in steps and tests run at each change. The friction losses shown by curve *A* were obtained with the crankshaft in its bearings, and the flywheel, brake pulley and outboard bearing in place; but with the piston, connecting rod and cylinder head not assembled, the air suction valves and handhole plates of the upper base omitted, and the injection pumps out of action.

Friction of Parts

The piston and connecting rod were then added, and with all of the rings omitted from the piston, curve *B* was obtained. Upon fitting the piston with five rings the losses followed curve *C*.

The next step was to bolt the handhole plates and air-suction valves to the upper base, thus compressing the scavenging air in the crankcase. This gave curve *D*.

Finally, the cylinder head and combustion chamber were added, completing the assembly, with the result that the losses assumed the values shown by curve *E*. This completed the series of tests made with 250-lb. compression.

A new cylinder head was then installed which reduced the clearance volume and increased the compression pressure to approximately 500 lb. With the engine fully assembled, as in case of curve *E*, the increased compression gave curve *F*. Upon removing two piston rings, the engine operated with three rings only and gave curve *G*. On the next series two additional rings were removed, resulting in curve *H*. With all the piston rings removed so that there was no seal between the piston and cylinder excepting a film of lubricating oil, curve *H* was obtained.

It will be noted that the losses are proportionately higher at higher rotative speeds. It might be well to mention here that the bearings and cylinder were oiled by a mechanical lubricator.

When obtaining curve *D* the crankcase was closed and scavenging air was pumped. The maximum scavenging pressures were measured with a Maihak indicator having a suitable spring for the purpose and were as shown on the chart.

As has been stated, curve *E* represents all the losses. A small amount of cooling water was circulated through the water jackets while these tests were made. The compression in the main cylinder was measured with a Maihak indicator; the results are given on curve *E*.

Results of Higher Compressions

It is interesting to note that the power losses due to friction, as represented by curve *C*, were 4.45 hp. at 400 r.p.m., and the power losses due to scavenging and compression were 6.7 hp. (curve *E* minus curve *C*). Theoretically, and assuming no loss due to the slight cooling, the engine should give back on the expansion stroke practically all the power absorbed during compression. However, since a piston cannot be made perfectly airtight, the engine loses a certain amount of air, which is reflected in the power consumption. Due to the pressure on the piston, the side thrust and bearing pressures have increased, and therefore the friction losses are greater than represented in curve *C*. No doubt the piston ring friction has also been increased, since the compressed air has leaked underneath the rings, forcing them against the cylinder walls with greater pressure.

With the compression raised, curve *F* represents all the losses of the engine as in test *E*, but operating with a compression of about 500 lb. The piston was equipped with five rings. The compression pressures observed are given in Table I.

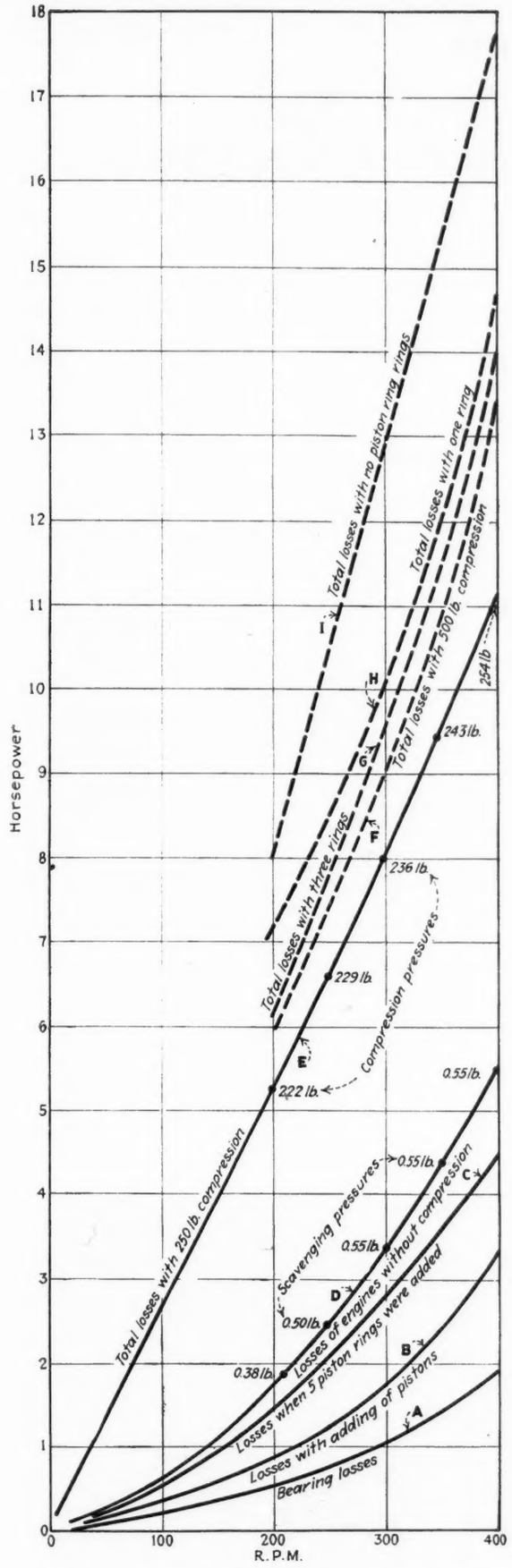
Offhand, it might be assumed that after two rings were removed, curve *G*, the leakage of air along the

TABLE I—COMPRESSION PRESSURES (500 LB. NORMAL)

	Number of Rings on Piston			
	5	3	1	0
R.p.m.	(Compression, Lb. per Sq. In.)			
200	422	436	421	145
250	443	450	436	164
300	458	465	450	179
350	483	486	465	201
400	500	507	486	214

TABLE II—MECHANICAL EFFICIENCIES AT VARIOUS BRAKE LOADS

Brake M.e.p.	Brake Hp.	Indicated Hp.	Mech. Eff. Per Cent
30	25.8	39.2	65.8
40	34.4	47.8	72.0
45	38.6	52.0	74.2
50	43.0	56.4	76.4
60	51.5	64.9	79.5
70	60.0	73.4	81.8
80	68.8	82.2	83.7
90	77.2	90.6	85.5
100	86.0	99.4	86.5



Mechanical losses in a two-stroke-cycle oil engine

piston, would be greater than in test *F*, when there were five rings, which would be reflected in lower compression pressures. But, as may be seen from Table I, this was not the case, since these pressures were slightly higher. This minor discrepancy has not yet been explained. A slight misalignment probably took place during the dismantling and reassembling of the piston for the removal of the rings, thus increasing the power a small amount. It appears that three piston rings are sufficient, and that additional rings are simply an added unnecessary expense and is the result of an acceptance of a general engineering practice.

When two additional piston rings had been removed, as with curve *H*, the engine operated with one ring only. The supposition made as to test *G* seems to apply, since the compression pressures were lower than in the *F* and *G* series.

All Rings Removed

The piston was from 0.008 to 0.010 in. smaller than the bore of the cylinder; consequently when all the rings were removed a considerable amount of air was discharged between the piston and the cylinder, which caused a large increase in the power absorbed. It is easy to understand why the compression pressure increased very considerably with an increase of the rotative and piston speeds. Compared with 200 r.p.m., the time for leakage was cut in half at 400 r.p.m. and the compression pressures increased.

If the friction and compression losses are assumed to be constant for all loads at a given speed, 13.4 hp. at 400 r.p.m., as shown by curve *F*, the brake horsepowers, the indicated horsepowers and the mechanical efficiencies will have the relations given in Table II. No doubt, due to the increased piston pressures during the expansion stroke at high brake mean effective pressures, the consequent increase in the piston side thrust and bearing pressures augment the friction losses. The actual mechanical efficiencies, then, are below those tabulated. But if the mechanical efficiency was ascertained by indicator diagram, the accuracy of the result, due to indicator errors, will not be better than the accuracy of the values given in Table II.

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The Production of Lubricating Oil By the Edeleanu Process

SEVERAL YEARS' research on the production of desirable lubricating oils from paraffin-base crude has led to the adoption of the Edeleanu process by the Bayonne refinery of the Tide Water Oil Company.

This process is based upon the selective solvent action of pure liquid sulphur dioxide, which has the property of completely dissolving those compounds in petroleum distillates that are most susceptible to decomposition and oxidation in service. The paraffin and naphthene hydrocarbons are insoluble in the solvent at low temperatures. The removal of the easily oxidzed and sludge-forming compounds makes Edeleanu-treated oils especially desirable for lubricating high-speed turbines and engines, where conditions conducive to rapid oxidation usually prevail.

Stepped Boiler Drums Widely Used in Germany

BOILER DRUMS of the type shown in the photograph will be strange to American eyes. In Germany these stepped drums have been used for years. The reason for the stepped surface is obvious. It permits straight tubes with connections to the drum at right angles to the surface. This type of drum is characteristic of the Garbe boiler in its original form and later modifications. The first Garbe boilers were built by the Dürrwerke Aktiengesellschaft (Ratingen-Ost, Germany) in 1908.

The sketch shows a Dürr boiler, built by this company as a modification of the original Garbe. This differs from the Garbe boiler in the use of flexible connections between the lower drums. It was found that with rigid connections throughout the boiler structure was not sufficiently flexible. Still later models than that shown use flexible connections between upper drums also.

A feature of the modern Dürr boiler is the fabrication of drums with a single longitudinal seam, so placed that it is removed from contact with the hot gases. The single-seam construction, however, is found to be impracticable for boilers containing more than 4,300 sq.ft. of heating surface, because then the pressing of steps into plates of the dimensions required cannot be accomplished with existing machines. It is, however, found possible in such cases to arrange both seams on the side of the drum away from the hot gases.

A recent development has been the welding of the longitudinal seam, and also the attachment of the heads by welding.

Among the advantages claimed for the Garbe and Dürr types of boiler are simplicity, good circulation, reduction of scale deposits in tubes and of ash deposits between tubes. The latter results, it is claimed, from the nearly vertical position of the front tube bank and the entirely vertical position of the back bank.

On the other hand, the increasing trend toward high pressures is working against the Garbe and Dürr types of boiler, according to information received from Germany. It is said that neither the Garbe plate nor the Dürr stepped plate may be pressed in such thickness that the walls of the drum are strong enough to withstand high pressures. The operating limit for Garbe plate boilers lies at about 300 lb., and of Dürr stepped plates at about 375 lb.

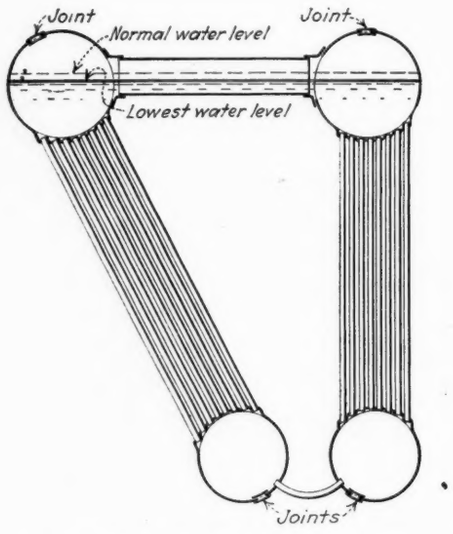

Fig. 2—Dürr boiler with stepped drums having single longitudinal seams

For higher pressures than these smooth drums must be used, and, in consequence, bent water tubes. This arrangement also makes possible one lower drum instead of two, with the resultant saving of the cost of one drum.

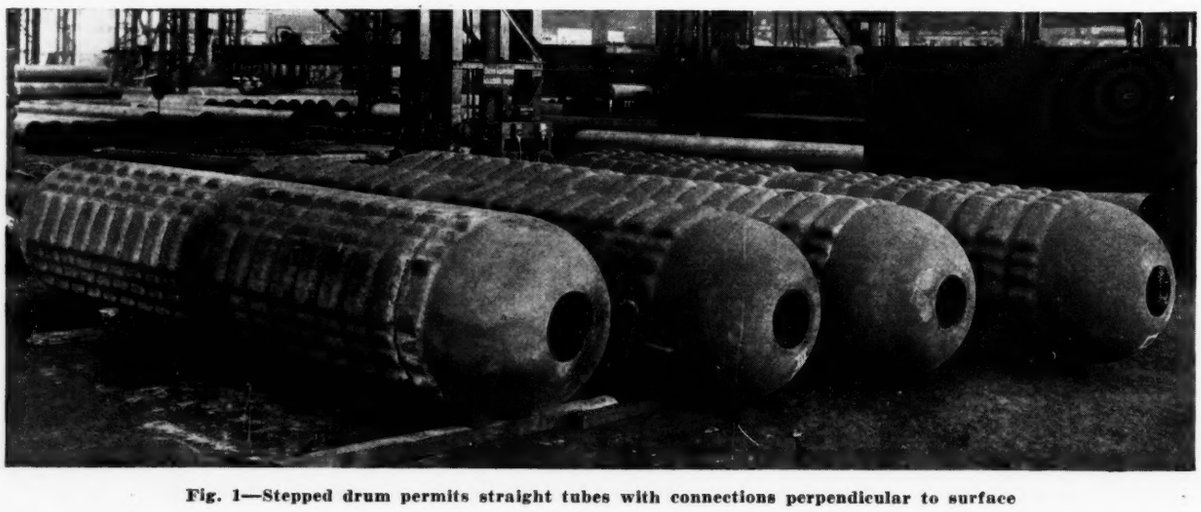

Fig. 1—Stepped drum permits straight tubes with connections perpendicular to surface

BUYING COAL FOR PROFIT—IV

Coal-Buying Limitations

In building a new plant or installing new equipment, careful analysis is necessary to avoid creating permanent coal-buying limitations. In many cases the capitalized value of these limitations is greater than the entire cost of the plant

By G. B. GOULD

President
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THE FIRST article of this series showed that wide variations exist in the original cost of energy in the coal market and that these are caused by a selective demand for certain physical characteristics. The second showed how the cost of steam is affected by this energy cost variation, and by efficiency variations. It became clear that energy cost is a major factor often overlooked in the search for B.t.u. efficiency.

In the third article actual plant case studies checked these general conclusions. The present article, concluding this series, shows the economic seriousness of permanent coal-buying limitations acquired in the building of a plant or the adding of new equipment.

It is only by the review of a variety of actual cases that one can possibly come to realize the almost infinite number of combinations of conditions possible. This is partly due to the complex nature of the coal market, the original source of energy, within which the individual economic values are governed by the combined effect of thousands of individual preferences in coal selection.

The Human Element in Coal Buying

Some of these preferences are founded on sound engineering analysis of the plant's requirements, but a very large number are still based upon habits of thought and conclusions about coal values which have grown out of isolated and unrelated coal-buying experiences, upon well-intended but improperly applied methods of diagnosis. Some purchasers are influenced by the experiences and preferences of *other* plants, or by the sincere but uncritical preferences of firemen. And, to top it off, there are the purely personal and social influences which sometimes weigh more heavily in coal selection than economic or engineering advantage. But underlying them all, even the last, there is the engineering individuality of each plant, which has its effect in one way or another on selective demand for different kinds of coal.

And curiously enough, a failure to recognize a real absence of coal-buying limitations may be just as costly as their existence. This was illustrated in the cases of Plants 2 and 3, cited in the preceding article.

Many of the existing cases of costly coal-buying limitations result from a lack of understanding of their real cause, and many are being acquired, for the same reason, in plants being built today. It is easier to describe the economic significance of these coal-buying restrictions than it is to explain their causes.

At the outset it can be said that those coal-buying limitations which carry the more severe economic penalties are not due to the inherent characteristics of the various makes and types of coal-burning equipment. These different types of equipment will vary in cost of operation, cost of maintenance, and in their efficiency limits under identical conditions of service. But such differences as exist among them are not the basic cause of the wide range of coal-buying requirements, which has a greater influence on individual steam costs than the whole range of efficiency found in existing plants.

The economic penalties that are paid in one way or another as the result of a limited range of coal selection are usually caused by a lack of adjustment to each other of the various elements in the steam-generating unit. It is a matter of proper proportions. If a man has one arm or one leg six inches shorter than the other, it is obvious to anybody that he is deformed, and correspondingly handicapped. But a deformed steam plant is not so easy to recognize.

Steam generation involves four separate but closely related operations. (1) The coal must be introduced into the furnace, and supported there until its heat is released; (2) air must also be introduced into the furnace; (3) the two must be mixed in proper proportions for efficient combustion, and (4) the heat so released must be recovered by the boiler, and its auxiliary heat-absorbing equipment. Each of these four operations has its own equipment: the boiler, the combustion equipment, the fans and stack, and the furnace.

Three of these one buys ready-made, as it were, while the fourth too often "just happens" as a convenient housing instead of being deliberately designed as a definite part of the steam-generating equipment. Now it is chiefly lack of proper adjustment among these four parts of the steam-generating unit that causes the most costly coal-buying limitations, even though every bit of purchased equipment in the combined unit is of the highest reputation.

It is not the purpose here to set out any definite rules or formulas by which a properly proportioned plant can be recognized, for that is impossible. It must be remembered that these proportions have to be adjusted to the coal characteristics of the section in which the particular plant is located. A plant highly successful in Boston might easily be seriously handicapped if duplicated in Philadelphia. The plant successful in Philadelphia might not do for Chicago or St. Louis. In other words, it is impossible to intelligently deal with steam generation, whether from the standpoint of coal selection, plant operation or design, without considering the underlying facts of the particular section of the coal market involved. But the physical laws and principles which govern are the same, although they may have to be applied differ-

ently. With these reservations it is possible to discuss, briefly, how the proportions of the four main elements of a steam-generating unit may affect the economical purchase of energy in the coal market.

Effect of Grate Area

To provide an anchor point, assume that the boiler and other heat-recovery devices are capable of absorbing efficiently whatever heat is released and of supplying as much steam as the plant needs. Assume also, for the moment, that the coal is to be introduced into the furnace by some kind of a mechanical stoker, and that it will be necessary to burn 3,000 lb. of coal an hour. This quantity is fixed by the steam requirements of the plant.

Now obviously the amount of coal burned on each square foot of grate per hour will depend upon how much grate area is provided. If this is 90 sq.ft., 33⅓ lb. of coal per square foot per hour will be burned, but if the grate area is 125 sq.ft. this figure will be only 24 lb. With the CO_2 percentage remaining constant, the higher this rate of combustion is per square foot of grate, the higher will be the temperature of the furnace and the fuel bed.

We know, of course, that the temperature at which the ash in coal will melt varies among the different mines, and over a different range in various sections of the coal fields. It follows, then, that the smaller the grate area in proportion to the steam output, the higher will be the limit of fusing point for a coal which can be used without suffering from clinker trouble. And, this, we have already seen, means a definite and costly coal-buying limitation.

This can be modified, as was done in the case of Plant 1, described in the preceding article, by operating with low CO_2, and consequently depressed efficiency, and with cheap coal. Such a situation may obscure the fact that the plant is really suffering from a coal-buying limitation and make it look as though the equipment itself is inherently incapable of a proper efficiency. The actual fusing point required may also be modified somewhat by selecting a sized coal, but that also involves a penalty in the basic cost of energy, because the price of such a coal is higher in proportion than its energy value is above a slack coal from the same mine.

This kind of coal-buying limitation is sometimes thought of in terms of boiler rating, as though that were the only determining factor. But if two boilers of the same size were erected, one over a grate area of 90 sq.ft., and the other over 125 sq.ft. of grate, the latter unit would operate at 200 per cent of rating with a lower fusing point requirement than the former one at 150 per cent. This illustrates the point, incidentally, that any type of coal-burning unit will impose *some* coal buying limitation at *some* rating. The important thing is to have the proportions right for the required steam output and for the kind of coal yielding the best energy value in the market.

Load Increase Makes Coal Unsuitable

It can be readily seen, too, that an increase or decrease in the steam demand of a plant over a period of time may radically change the controlling factors in coal selection. In this way it sometimes happens that a coal which has been regularly used with satisfaction suddenly becomes very unsatisfactory when the critical point in combustion rate is passed. If this occurs in a plant in which the coal characteristics are not regularly determined, and the plant load measured, it is quite likely that a change in the quality of the coal will be blamed for all the trouble. A similar situation can arise from a change in the character of the load, which increases the maximum load for only two or three hours, for the coal must be selected to meet the maximum combustion rate, not the average.

The same thing can happen if the grate area is decreased. This, of course, does not happen so often, but it is possible, as the following story shows. A small manufacturing plant in New England replaced hand-firing with a stoker. This plant had been using a certain coal for years.

As soon as the newly equipped stoker-fired unit went into service this coal began to give trouble. A fusing-point determination showed that the coal was quite within the normal range in this respect for this mine. Further investigation disclosed the fact that the stoker provided 25 per cent less grate area than the boiler formerly had under it when it was hand fired. The load had not changed, but the combustion rate had, and this plant had acquired in the guise of an improvement a continuing economic penalty as a result of not analyzing the situation first.

Limitations Caused by Furnace Volume

Closely related to the ratio of grate area to steam output is the matter of furnace volume. While this is not ordinarily the major source of a fusing-point limitation, it may modify it, for the larger the furnace the lower will the average furnace temperature tend to be. The design and size of the furnace will have an important bearing on maintenance costs, which are closely tied in with combustion rates. Smokeless combustion is also related to furnace design and volume, and in the East, where there is a wide range of choice in coals with respect to their volatile content, and in the cities a steadily growing opposition to smoke, a plant is apt to find itself limited to low-volatile coals. If this is coupled with other coal limitations the economic penalty attached may be substantial.

The Grindability Limitation With Pulverized Coal

The development of pulverized coal burning presents a different set of conditions, as far as coal selection is concerned. The fusing point has become less important, providing furnace volume is adequate, but discrimination among coals according to grindability has become necessary. In somewhat the same way that grate area, steam load and fusing point are related, so are the grinding capacity of a pulverizer and the grinding characteristics of different coals related.

A particular mill may be able to deliver enough coal of a given fineness to meet the plant load, if the coal selected is one that is easy to pulverize. A coal with a lower grindability index may either cut the capacity of the mill, and consequently of the boiler plant, or it may deliver coarser coal to the furnace.

In one case recently a plant had been using for some time with good results a coal having a grinding index of 36-58 on our scale. Another coal very similar in character was bought "on trial." Immediately slagging on the tubes began, nearly shutting the boiler down within a few hours. Tests on this coal showed that it differed from the regular coal in only one observable respect—its grindability index on our scale was found to be 25-33.

While the air supply for combustion is usually ade-

quate, it may also create a coal limitation if it is deficient, for it may require a sized coal. The air supply and its regulation is more closely related to efficient operation.

It can be seen, therefore, that whatever method of coal burning one uses, the economic success of the plant depends upon having the coal-preparation equipment, the coal-feeding mechanism and the furnace *properly proportioned*. This is more important than the choice of a particular make of equipment.

In addition to these particular physical characteristics of coal which make certain coals more or less desirable, and which can be measured with their effect on performance related to each plant's individuality, there exist in the minds of many operators other indefinable distinctions. Some of these may be well founded, but an analytical study of a large number of plants indicates that many of these preferences result from methods of appraising coal values which make unmeasured and unidentified variations in *operating conditions appear* to be the effect of undefined differences in coals. This can only be avoided by having records of performance that are complete enough to permit of accurate discrimination among all the factors affecting the final result.

Causes of Dissatisfaction With Equipment

Ignorance of the major importance of *proportions* in a steam-generating unit has some unfortunate byproducts in addition to the creation and perpetuation of uneconomical plants. The manufacturer of combustion equipment is frequently held responsible, not only for the proper functioning of his equipment as it may be affected by its design and manufacture, but for its performance *in conjunction* with the other parts of the unit, particularly the furnace, over the design of which he may have had little or no influence. In case of failure, the customer suffers a loss, and he naturally places the blame on the equipment. The manufacturer of the equipment loses either financially or in the loss of good-will.

It may be argued that the seller of the equipment assumed the obligation of seeing to it that his customer made a proper application of the equipment to his service requirements. Theoretically he should, but in many cases engineering limitations are imposed by the buyer that are unwise from his own standpoint and unjust to the seller.

Ignorant of the practical significance of plant proportions and the details of design, the buyer of combustion equipment frequently places too much emphasis on the first cost and too much reliance upon guaranties, instead of upon well-informed engineering judgment of his own or his advisers.

Equipment Buyers Must Use Application Intelligence

In an ideal world the seller would insist upon proper engineering application of his equipment. But as a practical matter, under stress of keen competitive conditions, the buyer unwittingly compels the maker of equipment to furnish what he (the buyer) wants most—low first cost and generous guaranties. The result is stokers or pulverizers that are too small, furnaces that are inadequate, disputes about guaranteed performance, and, finally, coal-buying limitations that impose a continuing penalty in the market, which, if capitalized, would exceed the whole cost of the equipment.

It all comes from the modern tendency to shift too much of the responsibility for sound engineering from the owner of the plant to the shoulders of the makers of the combustion equipment. The old-fashioned theory of *caveat emptor* had at least one virtue in that the buyer recognized the necessity of exercising his own discriminating judgment of value.

One of the evils of a "buyers' market" seems to be that the buyer not only wants the better values, but in addition wants to evade the necessity of being well-informed and discriminating. This works with respect to many commodities and products, but it is particularly unsuccessful in the case of both coal and combustion equipment, because the successful use of both is dependent upon some factors beyond the control of the seller but within the control of the buyer.

This is not said with any idea of relieving the producer in either of these fields of his proper responsibility, but to point out that the buyer cannot avoid, as a practical matter, the inevitable risk of economic penalty which follows from trying to pass over to the seller the responsibility for well-informed and discriminating engineering judgment in the selection of either coal or combustion equipment.

If the buyer's staff has not the training, experience or technical facilities necessary, he should provide himself with properly qualified advisers. Relying on producers' guaranties, as a substitute for sound engineering judgment on the part of the buyer, has been overdone to the detriment of every one concerned.

To Sum Up "Buying Coal for Profit"

Article I—In general, the easily obtainable difference of 50c. per ton in coal price (for a given heat value) will have a greater effect on the cost of steam than a 10 per cent difference in efficiency.

Tabulation of available coals, grouped according to physical characteristics and the energy purchased by one cent, will often reveal B.t.u. bargains usable in the given plant.

Article II—Of 76 coals available in a certain Eastern district last summer, the twelve best bargains averaged 71,000 B.t.u. for one cent, and the eight worst 57,000 B.t.u. This actual range of coal-market values affects the coal cost per thousand pounds of steam nearly twice as much as the spread in efficiency between 64 per cent and 72 per cent.

The problem is to design plants for coal-buying freedom as well as thermal efficiency, and to select coal to take maximum advantage of the possibilities.

Article III—This is more than a theory. Case studies of several plants show that very important savings can be made by intelligent coal buying, and that these can often be combined with higher efficiencies.

Article IV — Plant builders and purchasers should watch carefully the coal-buying limitations that are built into a plant. These are not generally due to the inherent characteristics of the type of coal-burning equipment used, but to undersized or other improper application. Such limitations carry a severe economic penalty.

Hydro-Electric Units Operated as Condensers

Operating hydro-electric units as synchronous condensers under certain load conditions offers possibilities of large economies in plant operation. In this article is told how units in the Holtwood plant of the Pennsylvania Water & Power Company are operated as condensers, how the problems encountered in this operation were solved and the saving attained from condenser operation

By H. A. VON EIFF

Efficiency Engineer
Pennsylvania Water & Power Company

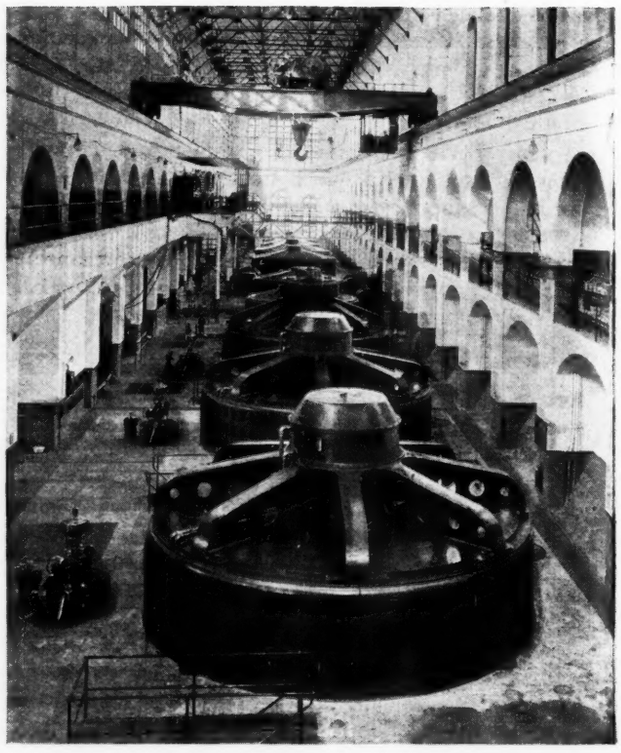


Fig. 1—The Holtwood plant has eight 25-cycle and two 60-cycle units

TO GIVE the reader the condenser operation story at Holtwood, it is necessary that the historical background of this plant, transmission system and service requirements of the customers of the Pennsylvania Water & Power Company be understood. The plant was originally designed for ten similar 25-cycle units, the first being placed in commercial operation on Oct. 23, 1910. Power from this unit was supplied to the Consolidated Gas Electric Light & Power Company of Baltimore by two 70,000-volt transmission lines, 40 miles long. Four units were placed in service in 1911, one in 1912 and a seventh in 1913. These seven units all have double-runner, francis-type turbines and are similar, except that No. 6 and 7 units are designed for a higher head and specific speed and greater capacity than the others.

In 1914, the last 25-cycle unit, No. 8, was installed and differs from the previous machines in that it has a single runner with exposed vane-operating mechanism and the runner's bottom is at elevation 116.5, whereas the lower runner's bottom on units 1 to 7, is at elevation 99.1. It was not until 1924 that the last two units were installed. These are 60-cycle, single-runner machines, somewhat similar in design to No. 8 but of greater capacity than any of the eight previously installed. A general view of the generator room is shown in Fig. 1.

In 1913 a contract was made with the Edison Electric Company of Lancaster to supply 25-cycle energy to Lancaster, Pa., over two 70,000-volt lines, 14 miles long. Holtwood was then supplying power to two customers and depended on the flow of the Susquehanna River for its source of power, with the make-up power, during low flow, supplied by the Baltimore steam plants. During the period from 1910 to 1921, inclusive, the capacity of Holtwood plant, under actual load and flow conditions, together with the Baltimore steam plants was sufficient to take care of the system load (Baltimore and Lancaster) requirements and no thought was given to operating a hydro unit as a condenser. In the latter part of 1922 the river's flow was lower than at any time since 1910. Coincident with the low flow, the system's peak requirements increased rapidly, after the industrial slump in 1921 and 1922. Also during this low-flow period, a 20,000-kw. steam turbine failed at the Baltimore plant.

These simultaneous occurrences brought about a study to conserve the water at Holtwood for peak operation so as to keep the required steam capacity to a minimum. Previous to this, Holtwood plant had never been completely shut down, as it was impossible to maintain normal voltage at Lancaster because of the voltage drop when power was supplied to Lancaster from Baltimore. One hydro unit was therefore operated in Holtwood during off-peak hours in very low flow to regulate voltage and carried a minimum load of approximately

5,000 kw. This loading, besides being inefficient for one unit, used water from approximately 9 p.m. to 7 a.m. which could, if conserved, have been used on the peak hours. A study of the value of this water for peak service at more efficient loading showed that the required steam generation during the peak hours could be reduced approximately 5,000 kw. This would also eliminate the necessity of operating two small inefficient boilers in the steam plants during peak hours.

Studies of Condenser Operation

Units 1 to 7 were first considered for condenser operation. It was soon realized that it was impractical to operate these units as condensers because the only water supply for the lower lignum-vitae guide bearing on five of them is from the upper draft tube and the other two units take their water supply from the pit. It would be possible to use these two units but, as previously mentioned, the elevation of their lower runner's bottom is at 99.1 ft. The normal standing tailwater elevation with the power house shut down and no water flowing over the dam is at 101.8 ft. Because of this condition the bottom runner would churn water, causing the machine to take excessive power when operated as a condenser.

It was not possible to free the runner of water by air pressure as the upper draft-tube outlet's roof elevation is at 101.0 ft. No. 8 unit was then the only other one available to be used as a condenser efficiently. This unit has only one lignum-vitae guide bearing and can be supplied with water from two sources. The bottom of the runner is at elevation 116.5 ft., which is well above normal tailwater level. The water for the guide bearing can be taken directly from the scroll case or from a header in the operating tunnel but it has been found best to use water directly from the scroll case. The two supply valves, strainer, control valves, and other equipment in the operating pit of No. 8 unit are shown in Fig. 2.

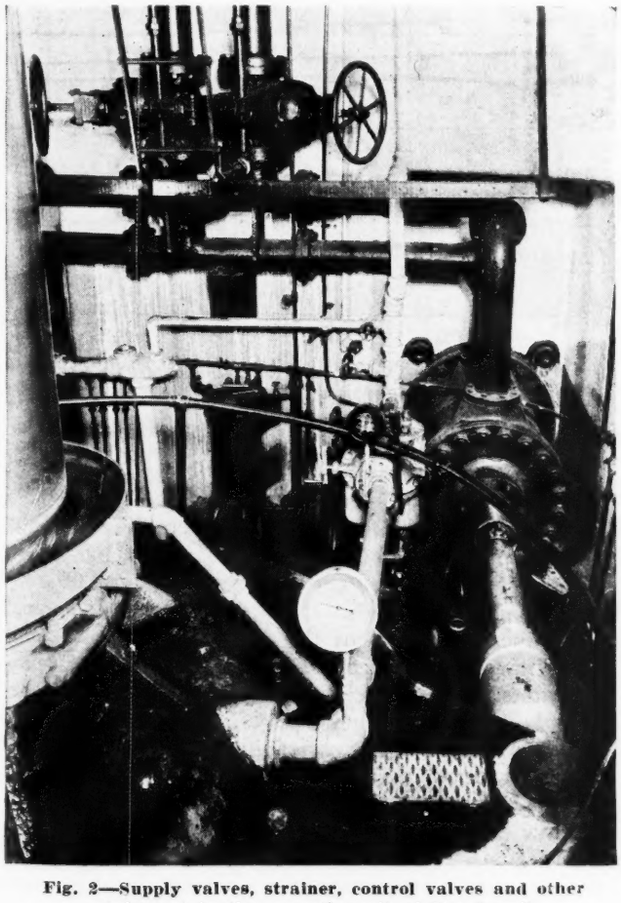


Fig. 2—Supply valves, strainer, control valves and other equipment in the operating pit of No. 8 unit

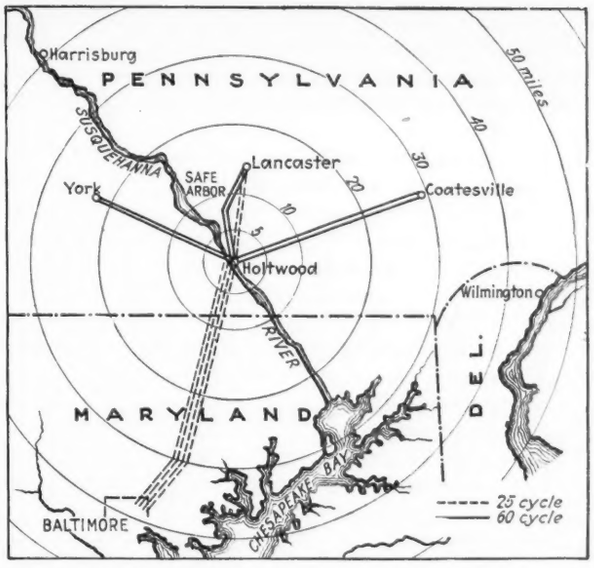


Fig. 3—Location of Holtwood plant and the system it supplies

It was decided to put this unit on condenser test with the idea that the only operating problem would be the cooling of the lignum-vitae bearing. During the first test run, which was for approximately 4 hours, the heating of the lignum-vitae bearing was not excessive and no other mechanical trouble of any kind developed. However, it was found that the unit took 3,800 kw. when operated as a condenser, where calculations indicated that it should have required approximately 700 kw. This increased power requirement was found to be due to the vacuum in the draft tube. The unit was originally installed with two 2-in. vacuum valves, which were used to drain leakage water from around the operating mechanism. Before the second test the vacuum valves were opened for approximately 10 min. before the unit was changed from generator to condenser operation. It was then found that the vacuum broke shortly after the unit had been changed over to condenser operation.

Unit No. 8 Operated as Condenser

After three tests had been made, the unit was approved for condenser operation, whenever the system conditions required. It has been used as such, frequently, since that time with satisfactory results. The only changes made in this unit since 1922 have been the installation of an in-feed watt-hour meter with a ratchet; the installation of a ratchet on the out-feed watt-hour meter; and a small potential switch on the control board so that the operators can change the connections of the indicating watt-meter, whenever the unit is operating as a condenser, so that this instrument will always read up-scale. These meters give the operator an accurate record of the energy used for condenser operation together with an indication of the power required.

In February, 1927, two additional 2-in. vacuum valves were installed, as the vane leakage had increased since the original test because of increased lost motion in the operating mechanism. An automatic air inlet valve was installed in August, 1929, with a maximum opening of approximately 30 sq.in. This valve is operated by the vane mechanism and starts to open when the gates close

to 45 per cent opening and is wide open at 35 per cent gate. This valve eliminated the necessity of having the hydraulic foreman open the four 2-in. valves every time the unit was to be used as a condenser and gave the operators direct control of the unit at all times.

It was found from tests that the capacity of this unit on part gate would be increased by having the air inlet valve open before changing to condenser operation and it was assumed that the efficiency would also be improved. This characteristic was discussed by S. Logan Kerr in an article appearing in the Oct. 19, 1926, number of *Power*. It may be stated here that in December, 1925, the lignum-vitae bearing was replaced with a rubber-lined bearing.

As stated previously, units Nos. 9 and 10, which are similar in design to No. 8, were installed early in 1924. The supply of 60-cycle power to Coatesville and York, Pa., began in the latter part of 1923, by means of two

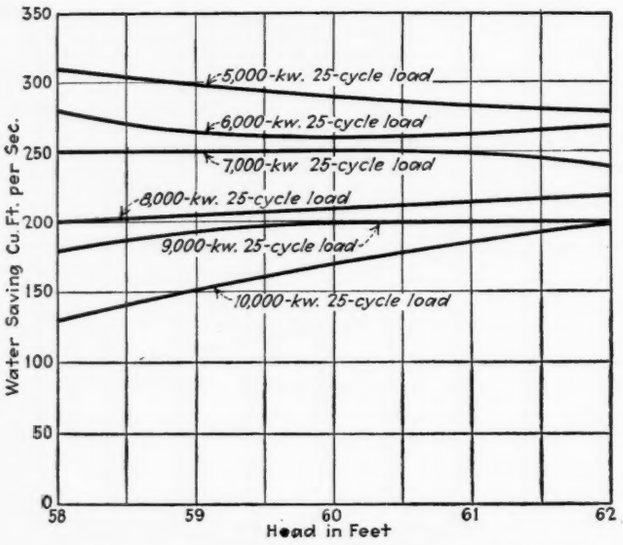


FIG. 4—WATER SAVING BY CONDENSER OPERATION ON THE 25-CYCLE SYSTEM

The water saving in second-feet when either No. 6 or 7 unit is operated to supply the total load with No. 8 unit operated as a condenser, for loads up to the capacity of one unit, as compared with dividing the load equally between the two units.

70,000-volt circuits to each city, which are 30 miles and 23 miles long, respectively. This 60-cycle power was supplied from the 25-cycle generators through two 5,000-kw. frequency changers before units 9 and 10 were installed. In 1925, 60-cycle power was supplied to Lancaster, over two 70,000-volt circuits, 16 miles long, and in August, 1925, the Holtwood steam plant was placed in operation with an initial capacity of two 10,000-kw., 60-cycle generators. This steam plant gave a reserve that with the 60-cycle hydro capacity was sufficient for the 60-cycle load requirements during the period previous to 1930. There was no need during this time to operate units 9 and 10 as condensers. During the 1930 drought an investigation was made with the object in mind of operating them as condensers. The problem did not differ materially from that of No. 8 unit except these runners' bottoms are at elevation 110.5 ft. and the standing tailwater level is now higher than formerly because of the backwater effect of the Conowingo pool.

Trouble was experienced in breaking the vacuum when the tailwater level was the same as the runner bottom elevation. These units each have two 2-in. vacuum valves and during one test air was admitted at approximately 100 lb. pressure through one valve to force the water from the runner. This was found to be satisfactory when there was sufficient compressor capacity available. It is now planned to install large automatic air-inlet valves on these units similar to the one on No. 8 machine. This will eliminate opening and closing of the vacuum valves by the hydraulic foreman, and will make the units automatic and under the direct control of the operators.

It has been found from actual experience and test that units 8, 9 and 10 will automatically change from condenser to generator operation by governor control when the system frequency drops below normal. The operators have been instructed to consider these units as spare capacity when they are being operated as condensers. These units have actually picked up load during system disturbances when the frequency has dropped. The head gates are always kept raised and the pits full of water when the machines are operated as condensers. It is operating practice to bring the units up to speed and parallel them as generators and then change them over to condenser operation.

Operates One Unit as a Condenser and One for Power Generation

Calculations showed that when Holtwood had to carry a 25-cycle or 60-cycle hydro load of one unit capacity but had to operate two units to provide for spare system capacity, it would be far more efficient to carry all the load on one unit and then operate the other as a con-

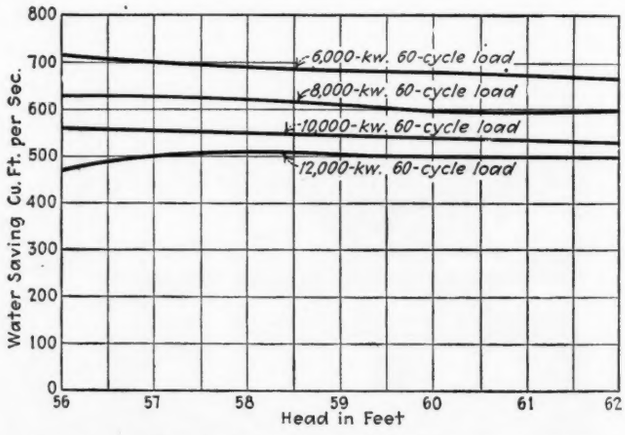


FIG. 5—WATER SAVING BY CONDENSER OPERATION ON THE 60-CYCLE SYSTEM

The water saving in second-feet when No. 9 or 10 unit is operated to supply the total load and the other is used as a condenser, for load up to the capacity of one unit, as compared with dividing the load equally between them.

denser. The curves in Figs. 4 and 5 were made to show the operators the actual gain in economy, to indicate to them the second-foot saving for various 25- and 60-cycle loads for different heads. This gain in economy, which is net since the losses of the unit operating as a condenser have been taken into consideration, is greater when units 9 and 10 are operated as condensers than for No. 8, because the former have a higher specified speed and lower part-gate efficiencies. It has been found that this gain in economy, while being greatest for loads of one unit capacity, extends to and includes loads requiring three units, at such times as Holtwood is needed to carry part of the system's spare capacity. Were these units not operated as condensers and considered as spare capacity, their operation would be at inefficient loads,

requiring a greater amount of water for the same load. A marked gain in the daily efficiency has been found by operating one of the units, 8, 9 or 10, as a condenser at such times that the required hydro generation was comparatively light.

Power for Condenser Operation

Holtwood is operated at all times with the 60-cycle system and the 25-cycle system (Fig. 3) tied through the two 5,000-kw. frequency changers. Condenser operation is necessary for power factor correction during low flow when the hydro plant is shut down in the off-peak hours, at which times the Holtwood and Baltimore steam plants supply the loads in York, Coatesville and Lancaster.

During the last six months of 1930, when Holtwood experienced the worst drought on record, No. 8 unit was operated as a condenser for a total of approximately 2,500 hours at an average hourly power input of approximately 600 kw.-hr., and units 9 and 10 were together operated as condensers for a total of approximately 300 hours at an average hourly power consumption of approximately 400 kw.-hr. The reason that units 9 and 10 have not been used more as condensers is because when the steam plant is running there is seldom need for the hydro units as condensers. Most of the time during low flow, only one 60-cycle hydro unit is needed and either unit 9 or 10 is operated at its most efficient loading, together with the frequency changers. No. 8 unit is operative and available as a condenser, and as many of the remaining 25-cycle units as are required to carry the balance of the load.

Tests are being made on units 9 and 10 to determine the quantity of air required to hold the water in the draft below the runner for various tailwater elevations. These data are to be used to determine the compressor capacity to supply necessary air for the Safe Harbor units, when they are operated as condensers, in the same manner as at the Holtwood plant. The runners at Safe Harbor plant will be of the Kaplan type and will be set below normal standing elevation to prevent cavitation. Consequently, air pressure will be required to depress the water in the draft tube below the bottom of the runner when these units are operated as condensers.

The subject of condenser operation is attracting considerable attention on the part of the hydro-electric engineers. The matter is being given special study by an N.E.L.A. sub-committee, headed by Frank M. Nash, superintendent, Norwood Plant, Carolina Power & Light Company, Mount Gilead, N. C. At the regional meeting of the A.I.E.E., Oct. 13 to 15, 1930, in Philadelphia, a paper was presented by S. Logan Kerr, research engineer of I. P. Morris and De La Vergne, Inc., in which it was explained how the automatic operator developed by the author served to place units automatically in condenser operation as needed. This paper was abstracted in *Power*, Oct. 28, 1930.

▼ ▼ ▼

Corrosion-Proof Pressure Vessels

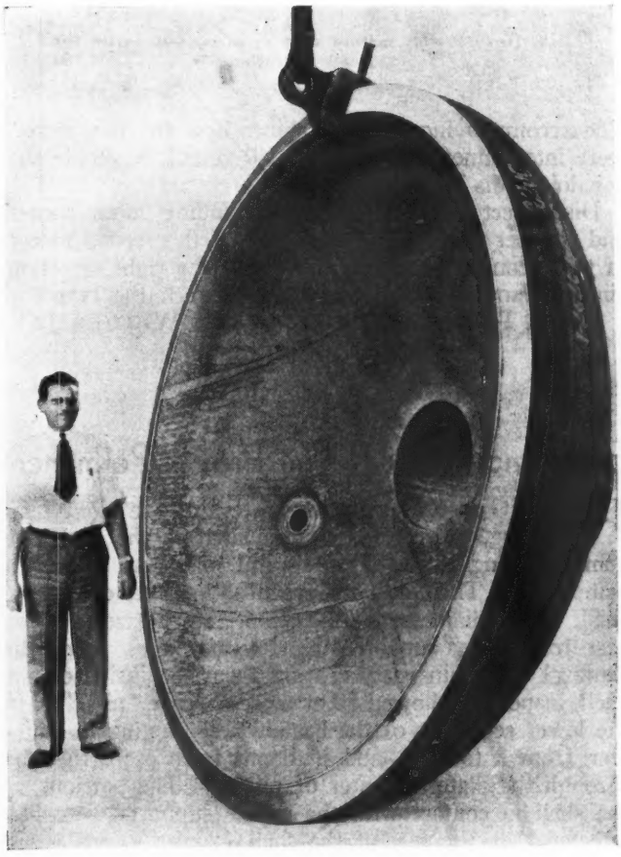
THE DEVELOPMENT of a new type of corrosion-proof pressure vessel has been announced by the A. O. Smith Corporation, Milwaukee, Wis. Originated to meet the difficult conditions to which oil-cracking stills are subjected, this type of construction is expected to find application wherever pressure vessels must combine strength with resistance to corrosive action.

The construction used employs sheet alloy, which is so bonded to the carbon steel of the pressure vessel as to make the lining an integral part of the pressure vessel, including heads, manways, nozzles, etc. The alloy lining is usually about 12-gage.

Near the end of 1930 three cracking stills thus constructed went into operation under high-temperature, high-pressure conditions. These vessels range in wall thickness from 3 to 5½ in., and each is lined with 12-gage chrome-nickel iron of the "18-8" class. Other lined vessels are under construction, and the study of the use of various alloys for lining is well advanced for many other services.

The success of this construction, the A. O. Smith Corporation states, lies in the bonding method used, which insures good heat transfer, thereby preventing stresses injurious to the lining. It is also pointed out that the strength of the corrosion-proof lined vessel remains practically constant, while an ordinary carbon steel vessel becomes weaker as the steel corrodes away.

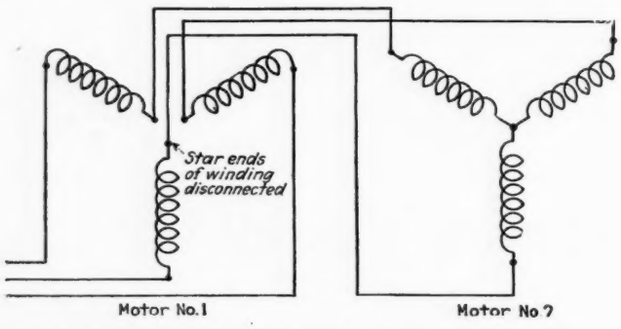
The application of these corrosion-proof vessels may be extended to retorts, digesters, tank cars, storage tanks, etc.



...RIGHT OUT OF THE PLANT...

Connecting Three-Phase Motors in Series

THE PLANT in which I am employed uses three-phase, 440-volt alternating current. We had two 8-hp. motors which ran together on a certain machine. These motors were wound for 220 volts and could not be used on a 440-volt circuit without rewinding. We ran the motors for a while with a transformer, but the transformer was needed elsewhere and the question of adapting these for 440 volts was again brought to mind.



How two 220-volt motors were connected in series for 440-volt operation

The accompanying diagram shows how the two motors were interconnected to run on 440 volts. A simple rule for doing this is as follows:

Disconnect the star ends of the winding on one motor, and connect them to the terminals of the second motor. If the second motor does not run in the right direction, simply transpose any two wires between the two.

Butler, Tenn. W. S. WHITING, JR.

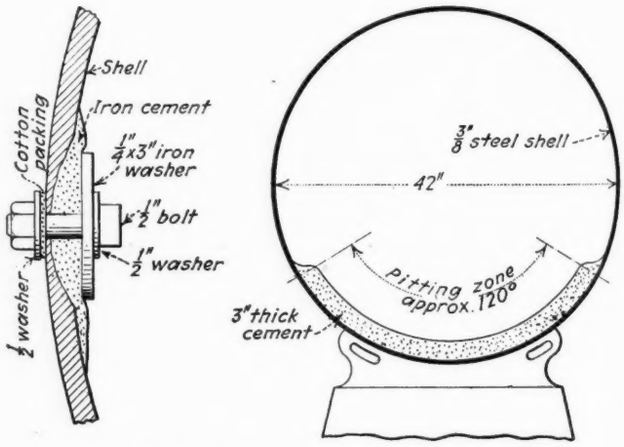
Emergency Tank Repair Proves Permanent

PITTING in the hot-water heaters of the plant I am operating, unexpectedly culminated in the shell bottoms "rusting through" in several places all about the same time. These heaters are of $\frac{3}{8}$-in. steel cylindrical shell, 42 in. diameter x 14 ft. long, set horizontally on cast-iron saddles supported by concrete piers. After the removal of a thin rusty coating from the inside of the shell, inspection showed 50 or more concave "pits," all in the lower segments of the heaters and ranging in diameter from 2 to 4 in. and in depth from $\frac{1}{8}$ in. to clear through the plate at center of pitting. The portions of the shell in contact with the saddle supports were less affected than the rest of the shell.

In making what was thought to be an emergency repair the "through" or nearly through pits were drilled and half-inch bolts inserted, each having a $\frac{1}{4}$ x 3-in. plate washer under the head on the inside of the tank pulling down on to a convex mass of iron cement (Smooth-On) which had previously been puddled into and around the cavity; with nut, washer and string grommet on outside of tank. The interior of heater had, of course, been cleaned down to the bare metal and thoroughly washed out and dried.

After the iron cement had set, twelve hours being allowed, the inside of the heater shell was painted with two heavy coats of a nitro-bituminous acid- and alkali-proof paint, the first coat being somewhat thinner to facilitate thorough penetration and to save drying time.

The paint was given twenty-four hours in which to dry, and as an added precaution the patched segment of shell was covered with about 3 in. of Portland cement, mixed one of cement to two of sharp, clean, white sand. The cement was applied "dry tamp" and its surface



How the heater was repaired with iron cement

smoothed or floated down to as fine a finish as a smooth bottle would give, and allowed four hours to set.

Precautions were taken to correct the conditions causing or permitting the corrosion, one of which was to install a temperature control that automatically maintains

the hot water at within 5 deg. of the normal temperature, 165 deg. Frequent inspections during the four years since this job was done show that the cement "bottom" is still smooth, unbroken, unchecked and tightly adhering to the shell; hence further repaired or replacement of the heaters is considered unnecessary.

W. SPOFFORTH, *Chief Engineer,*
St. Paul, Minn. Ancker Hospital.

Why Air Agitation in Can Ice?

IN AN EDITORIAL in the March 17 number, the question is asked "Is there any economic justification for air agitation of can ice during freezing?" I know of no better justification than the public demand. Anyone who has tried to sell white ice from a platform knows that for domestic use it is taboo—the housewife will not accept it. It is quite true that household refrigerating machines make white ice, but that is only in a 2-in. cube. If the ice manufacturer could profitably make and deliver a 2-in. ice cube he could sell white ice, because the appearance of white ice in a 2-in. cube and a 25-lb. or 50-lb. block is quite different.

While the public probably could be educated to accept white ice, where is the economic need for the enormous expense and effort that would be rquired. Take an 80-ton plant. The investment charge on air agitation equipment is about 3c. per ton, the operating charge is also about 3c. per ton. If air agitation was omitted, then the cost of ice would be reduced 6c. per ton. How would this affect the consumer? The total cost of manufacturing ice, including all production charges, interest, depreciation and taxes is $2 per ton. This cost could thus be reduced 3 per cent. At a delivered price of $12 per ton, the total manufacturing costs represent one-sixth of the consumer price. The maximum reduction to the consumer would thus be one-half cent. Obviously, the benefit to the consumer would be negligible.

The editorial further states: "It is questionable if the average user would notice the difference." The facts are that when an ice manufacturer obtains white ice from his tank he cannot sell it to peddlers nor can he dispose of it on his own delivery routes. He can only sell it for ice cream or milk cooling or similar uses. If the ice manufacturer could induce the housewife to accept it and not lose her trade, you may rest assured he would do so. Sad experience, however, teaches him that it cannot be done. And there would appear to be no economic justification for trying to do it.

EUSTACE C. SOARES, *Treasurer,*
New York City. R. B. Engineering Corporation.

Personal Equation May Determine Engineer's Progress

THE ARTICLE entitled "Personal Equation May Determine Engineer's Progress" which appeared in the March 17 number of *Power* must have made more than one reader ponder. There can be no doubt that the personal equation is the dominating factor in the fight for successful recognition of ability, however genuine it may be.

For a period of about five years I was employed by a utility company as its engineer-in-charge, during which time I concentrated all my years of technical and mechanical experience gained in high-class plants in a conscientious endeavor to obtain the maximum of efficiency, economy and safety out of its small plants. A new plant was built and connected up with the existing one, which was scrapped. Naturally after going through the worries of maintaining service while the change-over was being made, I expected to be given charge of the new addition. Not so. Instead I received a month's salary in lieu of notice with the intimation that my services were no longer required, with the inane reason "you have a distant disposition." Further inquiries as to "why," brought forth—"you did not take part in our social affairs and were not seen at the bowling alley," and from another "you appear to have spent too much time at the technical school at night." This all in spite of the fact that the company's figures showed a reduction in operating costs of 20 per cent, which they admitted.

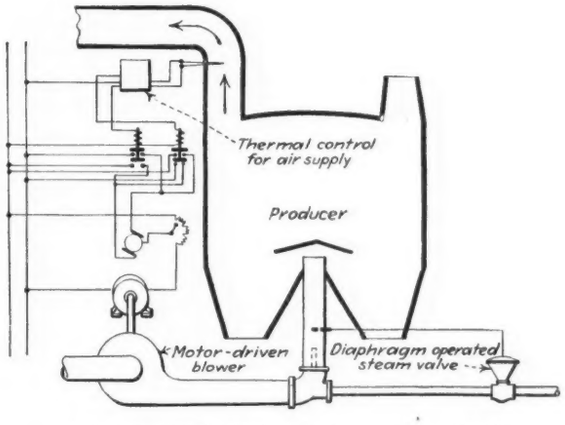
The designing engineer of the new plant whose assistants I had aided in every way, gave the sage advice; "The plant is not big enough for you; take my advice and from now on play politics," which advice I intend to follow. L. D. Ross.

Toronto, Can.

Automatic Control for Industrial Gas Producers

THE USUAL method of operating gas producers is rather haphazard and dependent on the observation of the gas man and furnace man.

In ordinary operation the furnace man either raises or lowers the steam pressure at the base of the producer, thus increasing or decreasing the volume of air and eventually the volume of gas leaving the producer. The



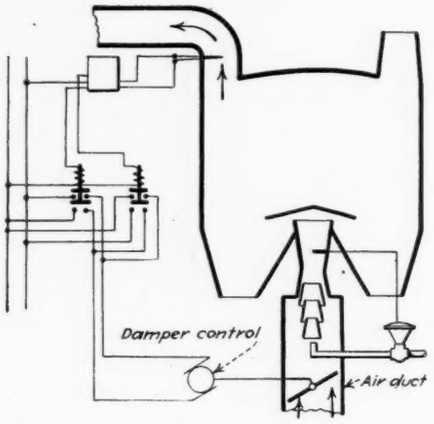
Producer control with motor-driven air blower

gas man periodically observes the quality, adjusting the coal feed as his producer works hot or cold.

Another common method is for the furnace man to signal the gas house for more or less gas, thus leaving the complete operation to the gas man, who ordinarily follows the foregoing sequence of operations and depends purely on his powers of observation as to gas quality.

The best indication of the gas quality is no doubt the CO content, as this furnishes the principal B.t.u. content of the gas, but it has been our experience that automatic CO recorders are not highly dependable without expert care. On a producer gas with a considerable tar content they would be out of the question as a means of control.

From a number of tests we have found the next best indicator of producer operation to be the terminal temperature. We found, over a period of time and number of tests wherein the terminal temperatures were checked



Control arranged to operate air damper on jet-type producer

against the gas analysis, that the best and most efficient operation occurred with a terminal temperature of 1,700 deg. F.

It is probable that some reader will take issue with me over this temperature, for I know that at least one manufacturer recommends a terminal temperature as low as 1,200 deg. F. I do not give this as a hard and fast rule but merely as a result of my own observations.

It has been found that when the air and steam mixture admitted at the base of the producer is at a temperature of 135 deg. F. the best results are obtained with respect to clinkering and excess cooling.

Using this satisfactory indication for the steam and air mixture, the control consists simply of increasing or decreasing the air supply as determined by the terminal temperature. This may be accomplished by speed control of a motor or steam driven blower supplying the air, or control of a damper on the jet type as indicated in the illustrations.

With a mechanical coal feed controlled by the furnace man, the requirements of more or less gas are fulfilled by merely increasing or decreasing the coal feed. For instance, assume that the gas producer is operating at the most efficient terminal temperature and more gas is required. The coal feed is increased. This will, in turn, lower the terminal temperature, which will increase the air supply. The increased volume of air will cause the air-steam mixture's temperature to drop, and the diaphragm-operated steam valve controlled by this temperature will function to admit more steam and bring it back to the proper degree. Thus the producer is automatically adjusted to the proper operating condition. On a lower gas requirement a reverse operation occurs.

With this control the human element is practically eliminated, leaving the producer operator to watch for holes that might blow in the fuel bed and to see that the ashes are properly removed. R. L. WILLIS.

Detroit, Mich.

Government Purchase of Foreign Diesels

PURCHASE of foreign marine diesels by the United States Navy, discussed in the Jan. 27 number, seems to have many aspects. If those at present in charge of governmental activities give a misleading interpretation of conditions as they now are, what assurance have we that there are not forces at work of a kind which will cause future development effort in this country to be poorly encouraged or even misdirected and appropriations to be misapplied?

Concerted action by engine builders inspired by enlightened self-interest probably is needed in larger measure, in which it might be well for the engineer to play a large part. The growing tendency to relegate the engineer to the status of a technical mechanic cannot help but affect the larger as well as the smaller issues in industry. For every gain there is a loss; and it is possible that whatever financial gain results from yielding but a technician status to engineers, is more than offset by losses from ill-direction of industrial strategy.

There would seem to be plenty of opportunity for the active, farseeing engineers of the country to advance co-operative programs aimed at putting the engine industry on a basis that would give it not only greater stability but also greater significance as a national asset. As an interesting coincidence, a British engineering journal has criticized editorially a tendency over there to copy Continental designs rather than foster native talent and development.

Whether American marine diesels have made good or have not made good, a serious situation portends from large-measure copying of foreign designs.

If we are at present to rely on copying, have we any guarantee that ten years hence our engines will be any more satisfactory to those controlling marine affairs than they are now? Although government money should be provided to assist development—if we do not know where we are going, a million dollars should not be spent for a ticket.

Someone who is nearer to the situation than we are has stated that it took ten years to reduce the fuel consumption of the Doxford engine by 0.05 lb. As a sample respecting one item only, that experience is a fair representation of the relation between size and time consumption on development work. Size has been mentioned as an obstacle in American achievements with marine diesels.

One current industrial condition will bear observation on account of ultimate national effects: Where development of machines, such as engines, in which the output and operating conditions cannot be definitely foreseen on the drafting board, devices wherein chemical and physical phenomena occur of which the reaction is more complex than a simple action of metal with metal, we seem to be growing in the practice of waiting on a ship dock for someone to step ashore with blueprints from which we can initiate production at once.

The significance of such a situation on our future engineering and industrial development is not as readily grasped as it should be.

If the path of industry is leading to larger world competition, the fellow who is copying now is sure to have only such superficial acquaintance with essential engineering knowledge as to be forever trailing—and copying.

Detroit, Mich. ROBERTSON MATTHEWS.

Atmospheric-Pollution Research Progress Reported in England

By A. C. BLACKALL
POWER *Correspondent in London*

THE INTEREST of the British public and of municipal authorities in the abatement of atmospheric pollution has been steadily increasing during recent years, and many of the chief cities, among other measures, now take observations of its extent in their own districts and co-operate with each other in endeavoring to interpret the results. The co-ordination of these local observations and research into the nature of pollution and the best methods of measurement are now being undertaken in the United Kingdom by the Department of Scientific and Industrial Research of the Board of Trade, which for this purpose has formed a special Atmospheric Pollution Research Committee. A standing conference of co-operating bodies has also been instituted to maintain effective touch between the central organization and the local authorities and other bodies, which are assisting in the work by making monetary contributions or by maintaining observations.

The sixteenth report on atmospheric pollution, which has just been issued, gives the actual data collected in the year ended March 31, 1930, together with the report thereon of Dr. J. S. Owens, superintendent of observations; a report by the standing conference to its consitutent bodies; and a short account of the work of the research committee.

At the present time the methods of recording pollution, though they may be subject to improvement, are more advanced than the interpretation of the results. Broadly, pollution is measured by the precipation on deposit gages calculated in metric tons per 100 sq.km., the monthly mean of which throughout the year can be compared with the corresponding average figure for a series of years.

On this basis the past year shows great improvement. Taking tar and sulphates as being specifically combustion products, a reduction in tar is shown at a majority of stations, and in sulphates at a very large majority of stations. The results, however, are remarkably "in and out," and are the more difficult to interpret because of the absence of returns from rural and seaside districts, which might serve as a basis of comparison with the more highly polluted urban districts. In a few stations continuous filter records are taken automatically, and in one or two ultra-violet radiation and daylight have been measured.

An investigation was commenced during the year into the distribution of pollution under different weather conditions. Norwich was selected as being sufficiently separated from other areas to prevent them from affecting the readings, and arrangements were made to take daily observations in the neighborhood of the city for a year. Doubtless the results of this investigation will be reported in next year's volume.

Seemingly, little can be done to reduce the extent of pollution through domestic fires except by mass propaganda in favor of smokeless fuels, and there is abundant evidence to show that the open hearth has still a strong hold on British householders. But in at least some districts in which free-burning cokes from the low-temperature carbonization of coal are available, these fuels are finding increased favor, and the demand is said to be outstripping supply.

INDUSTRIAL COOPERATION

Industrial pollution, on the other hand, comes from larger and from fewer sources. Lately the authorities are relying more on securing the co-operation of manufacturers than hitherto, and less on their "grudging compliance with the requirements of a by-law."

In Sheffield joint conferences have been held for some years between the Health Committee and the Sheffield Engineers' Employers' Association, and the joint conference has appointed a committee under the chairmanship of Prof. C. H. Desch for promoting research. It was proposed to spend $10,000 on the work, to be provided equally by the corporation and the association. But because individual manufacturers have been conducting experiments on smoke abatement, that step has been postponed until a report on the whole situation has been prepared by two investigators on behalf of the employers. The employers' association recognizes that undue smoke from chimneys which serve only boilers is unnecessary, and the association will not defend any members whom the corporation may prosecute for such default.

In steel-making processes, however, the protection given by the Act of 1926 may be necessary, and in practice all cases of chimneys serving such furnaces and emitting smoke are reported to the association for such an action as it may care to take. From Stoke-on-Trent it is announced that gas, and sometimes electrically heated kilns, have been substituted for coal-fired in the interests of atmospheric purity.

First-Quarter Power Output Shows Little Change

ELECTRICITY PRODUCED showed little or no change in March as compared with February, while a decline has been noted between these two months in recent years. Average weekly output amounted to 1,665 million kilowatt-hours during March.

Some improvement in the general business situation is indicated by the statistical evidence of the use of electric power during the month of March. Where January showed a decline in total electric production of 7.6 per cent below the same month of 1930 and February showed approximately a 5½ per cent drop, preliminary estimates based upon the reports of weekly output place the figure for the entire month of March at 3½ per cent below that of the previous year and 1 per cent below that of the corresponding month of 1929. Although the gains in the percentage figures have been progressive throughout the past month, they are, however, complicated to some extent by the extraneous factors of comparatively colder weather and a very considerable increase in irrigation pumping on the Pacific Coast.

The apparent improvement has, however, failed to carry into April, the second week of which showed a decline of about 4 per cent below the figure for 1930 and 2½ per cent below the same week in 1929. As indicated by the production figures, the industrial use of electric power at the middle of April was approximately 8½ per cent below that of last year and 11½ per cent below 1929.—*National Industrial Conference Board.*

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Stoney Gates Not Popular in Europe

AT A RECENT meeting of the Hydraulic Power Committee of the National Electric Light Association in Chicago, a report of the Sub-Committee on Experience With Different Types of Dams stated that the use of stoney gates was discontinuing in Europe.

This is a curious anomaly, since in America stoney gates were probably never so popular as at present. They are regarded by hydraulic engineers as representative of the best construction and have a record of continuous success in service over many years. Possibly the difference of the viewpoints at home and abroad lies in the fact that European gates are generally of much lighter design.

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MARCH SALES of mechanical stokers, as reported to the United States Bureau of Census by the eleven leading manufacturers in the field, totaled 63 stokers of 17,993 hp., as compared with 67 of 14,249 hp. in February and 89 of 32,403 hp. in March, 1930, and 117 of 42,432 hp. in March, 1929.

A.S.M.E. Birmingham Meeting Covers Wide Field

Hydraulic laboratories, coal grindability, heat transfer from steam, and blast furnace power plants among subjects discussed

MANY FIELDS were covered in the technical session of the semi-annual meeting of the A.S.M.E., held in Birmingham, Ala., starting Monday, April 20, and concluding with inspection trips on Wednesday and Thursday. Technical sessions on Monday and Tuesday dealt with manufacturing process, iron and steel, hydraulics, safety, railroads, fuels and petroleum, textiles, power, materials handling and machine-shop practices, management and aeronautics.

On Wednesday an all-day inspection was made of the Tennessee Coal, Iron & Railroad Company. On Thursday a similar all-day trip took in the Jordam Dam on the Coosa River. The principal social feature was a banquet on Wednesday evening, addressed by Dr. A. G. Howe, editor of *Industrial and Engineering Chemistry*.

The papers of chief interest to power engineers were those in the hydraulic and fuels and petroleum sessions on Monday and in the power session on Tuesday.

Stormy weather and rather unseasonable heat neither dampened nor wilted the enthusiasm of 350 engineers who registered for the meeting. This number included a splendid delegation of engineering students.

Much business was transacted, including such important items as the authorization of a Pure Air Committee. The sessions, which were well attended, were marked by lively discussions.

Speeches made by President Wright emphasized the importance of student activities. They stressed the responsibility of senior members to give individual help to students and to support their growth into engineers capable of performing the greater works of the future under more complicated conditions than those experienced by the present generation.

Mr. Wright spoke also of the industrial growth of the South and referred to Alabama, in particular, as an ideal setting for industrial development. "This section," he said, "has the climate for all-year operations under the best conditions." Nowhere in this country can such lavish natural resources be found. Not only are materials here but power and transportation."

Hydraulic Research

In a paper on the application of hydraulic laboratory researches, Ireal A. Winter, hydraulic engineer, of Allied Engineers, Inc., Birmingham, Ala., illustrated the many advantages of investigations with models and stressed the deficiency of scientific knowledge incidental to hydro-electric plant design. With curves and sketches he illustrated the test results obtained with many small models, using the wet-paint method. He showed that in many cases improper design features would have been incorporated in the larger structure if these models had not been made and tested in advance.

The illustrations included draft-tube models of the hydraucone and elbow types, of conical diffusers of scroll cases and of stay vanes.

More Scientific Data Needed

Concluding his paper, Mr. Ireal said "Data presented in the paper are necessarily limited. The main object has been to point out the many potential mistakes in resorting to individual judgment without thorough laboratory tests. It is as important to know what not to do as what to do. Throughout the paper it will be noted that many attempts have been made to use definite laws of motion to effect a proper design. The consistent failure of these attempts to produce the desired results is evident. A closer understanding of the application of fundamental principles to design will be realized when more scientific data are available to point the way.

"The necessity of making field tests is of first importance if the full advantages of experimentation are to be realized. It is most gratifying to note the steady increase in field tests being made. Only by experience can we learn the art of measuring flows up to 7,000 and 8,000 sec.-ft. with a fine degree of accuracy. Companies that have withheld their support because of the uncertainty of obtaining desirable results are now making plant tests and contributing their share to the general knowledge of the art.

"It is seldom possible to check the effect of various phases to turbine design in the field. The plant is tested, and the results obtained are for one condition only. This fact emphasizes the necessity for obtaining accurate absolute values of progress is to be noted by reference to other plants.

"A review of the effect of altering parts of the water passages generally considered non-essential gives encouragement to the idea that substantial increases in efficiency and simplification of structures are to be had by continued effort along the lines of research."

Mr. Winter's paper was followed by a lively discussion. The participants included William M. White of Allis-Chalmers Manufacturing Company., Professor Allen of Worcester Polytechnic Institute, J. D. Cutler of the Safe Harbor Power Corporation; also Carroll F. Merriam, L. M. Davis, G. W. Spaulding and R. L. Thomas, all of the Pennsylvania Water & Power Company.

Mr. Merriam warned against the danger of accepting the results of a few tests as a basis for the establishment of engineering dogma to be blindly followed. The only cure, he said, is to seek out the fundamental causes of hydraulic phenomena. This will require the finest talent available.

Srandardized Runners Advocated

Mr. Merriam named six leading hydraulic laboratories that have already standardized on runners of 16 in. diameter. He therefore suggested that this standard be generally adopted to simplify the exchange of equipment and to allow users the greatest possible latitude in the choice of a test laboratory.

Mr. Davis described a method of model draft tube construction found convenient by the Alden Hydraulic Laboratory. The models are built of wood frameworks, copper-lined.

"It is plainly evident," said Mr. Spaulding, "that a wealth of general knowledge would readily be available if the various agencies would pool the information obtained by model testing."

Discussing Mr. Winter's paper, Mr. Cutler stated that the efficiencies of the

water passages are already about 94 per cent, leaving little room for improvement.

Calibration of Large Nozzles

A paper by John R. DuPriest, professor of mechanical engineering, University of Minnesota, and by James H. Polhemus, general manager and chief engineer, Port of Portland (Oregon), gave details on the calibration of a large nozzle. It was pointed out that the use of standard test nozzles offers a simple means of determining the capacity of large pumps, but that these nozzles must be accurately calibrated.

Grindability of Coal

One great difficulty in the practical testing of pulverized-coal plants has been the lack of any standard method of rating or testing the grindability of the coal itself. A paper on this subject by R. M. Hardgrove, in charge of research and design for the Fuller-Lehigh Company, presented a new method of making such tests. "If accurate knowledge of the grindability and abrasive qualities of the coal could be determined as easily as the fusing temperature," he said, "it would be of considerable help to the coal buyer."

The method developed by Mr. Hardgrove is based on Rittinger's Law, which states that the work done in grinding is proportional to the new surface produced. The total surface of a given weight of ground particles, he pointed out, is inversely proportional to their average diameter if they are all of the same size and shape. It therefore follows that the work done in grinding to a given size is proportional to the reciprocal of the diameter of the particle. The method described may be outlined as follows: First the coal sample is prepared so that all particles are of practically the same diameter. Second, this sample is subjected to a definite process of pulverizing. Third, this partly pulverized sample is screened to determine the increased surface produced, according to the principle already mentioned.

2,000 Coals Tested

The principal tests were made with a special ball mill, using samples screemed between the limits of 16 and 30 mesh. Mr. Hardgrove's paper presented an extensive and valuable table, together with a map, showing the grindability of representative coals of the United States and Canada on his scale. This table was based on tests of more than 2,000 samples.

An interesting conclusion was that there exists an approximate relation between the volatile content of the coal and its grindability, although this relation is not absolutely dependable. Coals between 16 and 20 per cent volatile are usually of high grindability; this decreases as the volatile increases. In his conclusion the author expressed the hope that the A.S.M.E. will suggest a definite method for the determination of grindability.

The rapid development of natural-gas utilization in this country is producing major problems of engineering economics. Some of these were analyzed by Charles W. Merriam, Jr., of the Natural Gas Engineering Corporation, Birmingham. He pointed out that of all the gas utilized in this country in 1929 approximately 82 per cent was natural gas, and that in the same year over 4.4 times as much potential energy was contained in natural gas utilized as was generated in all of the country's hydro-electric central stations. During 1930, said Mr. Merriam, of the money spent in the sixteen Southern states for all construction purposes, nearly 22 per cent was for the building of pipe lines for the conveyace of petroleum products. He pointed out that, since transportation is one of the chief factors of the cost of gas service, the design of transmission pipe line becomes a highly important element of gas cost wherein engineers may play a leading part by the application of sound economic principles.

Mr. Merriam discussed in detail the various elements that make up the load, and methods of estimating the composite load served. He pointed to the importance of dump gas sales. He discussed flow capacities of pipe, power requirements, etc.

In conclusion, he stated that the proper selection of pipe-line design could not be made without going through the laborious process of making a separate pipe-line layout for each series of volumes and peak loads procurable on various rate scales. From the system design, estimation of the approximate ultimate investment can be made, with due allowance for depreciation and capitalization of operating expenses and taxes. From this investment the ratio of return may be obtained.

A paper presented by A. T. Brown, mechanical engineer, United Engineers & Constructors, Inc., Newark, N. J., presented a method for computing the heat transfer through single tubes with flowing water on one side and air-free condensing steam on the other.

Fairfield Blast-Furnace Power Plant

One of the latest blast-furnace power plants, built at the Fairfield steel plant of the Tennessee Coal, Iron & Railroad Company, was described and discussed in a paper by F. G. Cutler, Chief of the Bureau of Steam Engineering, Tennessee Coal & Iron Compay.

The paper showed that by the improvement in efficiency in general it is possible to increase the electric power generated from surplus blast furnace gas per ton of product about 50 per cent over what was an average practice nine years ago. This result is due to increased efficiency of the boiler plant as well as to the increased amount of blast furnace gas available.

The power plant consists of five boiler units, two 20,000 kw. turbine-generators and three 75,000 cu.ft. per min. turbine-blowers, with auxiliary equipment.

Each boiler is equipped with economizers, air heaters and superheaters, and the combustion chamber is provided with air-cooled hollow side walls, a bare-tube front-wall section above the burners and tubes faced with refractory and cast-iron protection for the back of the combustion chamber hopper.

Four of the five boilers are equipped with pulverized-coal burners supplied from coal-storage bins. The coal burned is a middle product of the coal washers. Automatic control of air and gas supply is provided.

Two steam pressures are used at this plant, the higher of 325 lb. gage (200 deg. F. superheat), supplying the main unit and main boiler auxiliaries, and the lower of 200 lb. (100 deg. superheat), supplying the condenser auxiliaries, boiler soot blowers and the blast-furnace plant for operation of bells, mud guns, etc. The line supplying this 200-lb. steam is connected to a battery of waste-heat boilers, this boiler plant supplying steam to a pump and compressor station, and several mills.

The condenser circulating-water pumps of the five main units are each driven by both motor and geared turbine, each of sufficient capacity to drive the pump, and the steam drive is utilized to the extent of the supply when available and to maintain sufficient exhaust steam supply to the deaërating type of open feed-water heaters.

It is, therefore, possible to supply steam from the blast-furnace system to the open-hearth system, and also to absorb surplus steam from the open-hearth into the blast-furnace system for operation of auxiliaries when it is available and maintain a uniform pressure on the mill steam system. The latter has a variable demand and is supplied from waste heat boilers. This connection does away with the necessity of auxiliary gas fuel for the waste-heat boilers.

When the plant was designed it was expected that there would be a surplus of steam from the open-hearth plant at all times, but, due largely to increased steam demands by the mills, there is usually a considerable amount of steam delivered from the blast furnace system to the open-hearth system.

An original connection with the Alabama Power Company is maintained for protection and regulation. Arrangements are made to deliver excess power to the power company when its hydro-electric stations would otherwise require help from its steam stations.

Nominations

The nominating committee reported the following nominations for officers to be voted upon by the membership and take office following the annual meeting in December: President, Conrad N. Lauer of Philadelphia; vice-presidents, R. M. Gates of New York, Charles M. Allen of Worcester, Fred H. Dorner of Milwaukee and W. B. Gregory of New Orleans; managers, A. J. Dickie of San Francisco, Eugene W. O'Brien of Atlanta and H. R. Westcott of New Haven; members of American Engineering Council, Conrad N. Lauer, R. C. Marshall, Paul Doty, R. E. Flanders, A. A. Potter, C. E. Ferris, L. P. Alford, J. H. Lawrence, Ely C. Hutchinson and W. H. Trask, Jr.

From Among Readers' Problems

Conducted by
L. H. MORRISON

HUNTING-TOOTH GEAR—*What is a hunting-tooth gear and what is its advantage?* D.R.

Frequently a train of gears consists of a driving gear, a driven gear and a gear placed between the two to transmit the motion from the driver to the driven. If the number of teeth in this intermediate gear is not evenly divisible by the number of teeth in either the driver or driven gear, then at each revolution any given tooth on the intermediate will contact with a different tooth on the driver and on the driven. This type of intermediate gear is called a "hunting-tooth" drive and is desirable, as it makes the tooth wear uniform.

BENT DIAGONAL STAY—*In an examination I was asked what I would do if I found, upon opening a boiler, that one of the diagonal stays above the tubes was bent so that after straightening it was two inches too long. What is the answer?* H.S.

This probably is one of the "catch" questions examiners are prone to ask. The intimation, of course, is that the boiler head had distended to a point where it elongated the stay two inches, and the stay bent when the head went back into place. Oviously the head could never have distended enough to lengthen a stay this amount, for, if so, all the tubes would have been pulled out.

The only answer is that the assumption should be made that the boilermaker had found one stay too long and had bent it at the time the boiler was fabricated. It should be replaced by a new one. But the question as to why the shop boiler inspector did not discover the stay before stamping the boiler as approved cannot be answered by the editor.

VOLATILE GASES IN COAL—*Just what are the volatile gases in coal composed of? I thought that coal was mainly carbon, hydrogen, a little sulphur and other minor impurities.* W.T.

A coal is composed of fixed carbon and hydrocarbons, as well as other minor constituents. The hydrocarbons, the volatile gases, are driven off as gases when heat is applied, and if not ignited will issue out of the chimney as smoke. The fixed carbon is the solid left, and this burns from the surface almost without smoke. As anthracite coal has much fixed carbon and little hydrocarbon, it is almost smoke-free. By proper furnace design and firing methods the hydrocarbons in bituminous coal can be burned without smoke.

RUST REMOVER—*In the July 15, 1930, number of* POWER *you described "An Economical Rust Remover," in which mention was made of P.907 oil. I have tried all the drug stores, paint and hardware stores around the town and none of them know what that oil is.* W.W.

P.907 mentioned in the formula is a trademarked product of the light spindle oil grade. In view of the many inquiries received on the subject, the original statement is reproduced, with the correction, as follows:

An economical rust remover may be made easily of ingredients to be found in any drug store. The composition is: 3 oz. petrolatum, 2 oz. light spindle oil, and 6 oz. tripoli.

The oil and petroleum are steamed together until they are warm. Then the tripoli is added and the mixture stirred until it is smooth. When spread on rusty tools or parts and rubbed off with a cloth, this mixture will remove the most stubborn coat of rust.

Two Questions for Our Readers

1. Is there any advantage possessed by vertical single-acting ammonia compressors as compared to horizontal double-acting? Does the variable clearance of the latter make it superior? A.C.D.

2. What is the smallest amount of heat needed per kilowatt output by any form of heat engine? L.H.

Suitable answers will be paid for and published in the June 2 number.

LONG EVAPORATING COILS—*What, if any, ill effect results from the use of long ammonia evaporating coils? In our plant each 1¼ in. coil is 1,500 ft. long.* C.V.M.

Two ill effects attend the use of evaporating coils of excessive length. In the first place, the ammonia starts to boil as soon as it passes the expansion valve into the coil. The boiling continues as the liquid flows along toward the outlet end, and all this gas must be accommodated, so that if slop-overs are not to occur, a portion of the coil, that toward the outlet, must be free of liquid. This reduction of heat-absorption surface reduces the coil refrigerating capacity.

The second disadvantage is that to cause a flow of gas to the outlet, there must be a pressure difference, and the longer the coil the greater this difference. As the compression power requirement depends upon its suction pressure, the lower suction pressure with the long coil entails an increase in the compressor power.

ISOTHERMAL AND ADIABATIC COMPRESSION—*The terms isothermal and adiabatic compressions are frequently used by engineers discussing air compressors. Just what do the terms mean?* F.F.

If the air drawn into the cylinder of a compressor is compressed adiabatically, no heat is lost to or absorbed from the cylinder walls. The air after compression has in it the heat possessed by the suction air plus the heat of compression.

If the cylinder is cooled, so that the heat equivalent of the compression work is removed as fast as it is created, the air temperature will remain the same as the suction air possessed.

Adiabatic compression requires more power than isothermal requires since it involves the raising of more heat to a higher temperature level.

SPECIFIC HEAT—*I frequently see the term "specific heat." Just what is this?* V.M.L.

Specific heat is the heat required to raise the temperature of a unit mass of any substance one degree. In the English system of measurements, the specific heat of a substance is the number of heat units required to raise one pound of that substance one degree Fahrenheit in temperature. The heat unit used is the specific heat of water, that is, 1/180 of the amount of heat necessary to raise one pound of water from 32 to 212 deg. F., and is called a British thermal unit.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

WITH the increasing number of roller bearing installations in power stations and in the industrial field, an ever-increasing number of operating men are becoming interested in the maintenance of these bearings. I should like to invite the readers having such bearings under their care to express an opinion on the following questions:

What schedule of inspection and overhauling do you follow for these bearings?

Are the intervals between inspections longer or shorter than with babbitted bearings of comparable sizes? On what do you base this difference?

What external indications do your operators have of the condition of races and rollers upon which they base their judgment that these parts are in good working order or need inspection?

MY OPERATING EXPERIENCE with ball bearings on steam turbines, turbine blowers, elevator-gearing thrusts and centrifugal pumps has proved the efficiency of the roller bearing as far as necessary maintenance and attention are concerned.

Using the correct type of lubricating oil as advised by the manufacturer, who found by experience that oil was the only positive lubricant for a high-speed ball bearing, as it covers every bit of surface, which grease can never do, the maintenance program with the turbine blowers called for draining of old oil, thorough washing out of housing with kerosene and renewal of oil once a year, at which time the wear down of the rotor spindle was checked. At the end of five-years operation no repair cost had been incurred and the wear down was negligible. Daily attention by shift men amounted to filling up the syphon feeder boxes to the indicated level.

The thrust bearing on a 20-year drum-type electric passenger elevator continued to give satisfaction, the balls requiring renewal and the end plate needing grinding about every five years. Wear down in this case could be determined by end play and noise in the gear case. The disadvantage was that the driving motor had to be taken back from its mooring when the coupling-end thrust was opened for inspection, which required additional labor and disconnection of feeder circuits and subsequent careful lining up of the motor with the worm shaft. Transmission oil, drained and renewed yearly, was the lubricating medium.

Ball bearings on centrifugal pumps gave entire satisfaction except in one case where an initial stress was placed on the overhung bearing by careless drawing up of bolts on a misaligned inlet pipe. This continued to give trouble by running hot until a supporting bracket carrying the weight of the pipe was fitted.

A worn race or bearing will make itself apparent by its noisy operation.

Roller bearings are more fool-proof but costlier to renew than the split babbited bearing, the wear down of the latter in many cases being rectified by a simple liner adjustment.

LESLIE D. ROSS.

Toronto, Canada.

GENERALLY SPEAKING, we use grease-packed ball-bearing motors in locations not easily accessible and exclusively on direct-driven centrifugal pumps fitted with ball bearings.

We overhaul all our motors every six months and periodically examine rotor-stator clearances with a feeler-gage.

Experience has shown that proper rotor-stator clearances are maintained over longer periods of time with ball-bearing motors than with sleeve-bearing motors.

We rely on the sound of the motor as an external indication that ball-bearing motors need attention. The feeler-gage clearance indicates when sleeve-bearing motors should have new bearing linings, an extra set of which we keep on hand and which are very easily and quickly replaced.

For belt-driven motors, we prefer the sleeve-bearing motor when belts are joined by the metallic clippers and ball-bearing motors with silent chain, V-belt or other endless belt drive. The sleeve-bearing seems better to withstand the continual shocks of the splicing hump as it passes over the pulley. With chains or endless belts there is no hump, and the ball-bearing motor is superior, for it maintains the rotor in the concentric position as heretofore mentioned.

Ball-bearing motors must not be used where there is any chance of acid, dust, etc., getting at the bearing, for its life will be short-lived.

The one particular advantage of the ball bearing is the length of the time it will run without attention to lubrication. There is a tendency for operators to overdose ball bearing with grease.

S. E. NICHOLS.

Chicago, Ill.

THE SCHEDULE of inspection shown tabulated is maintained in a power plant where 90 per cent of the auxiliaries have tapered roller bearings.

Type	R.P.M.	Observe and Feed	Oil or Grease	Inspect
Motor.....	1,750	shift	monthly	annually
Motor.....	3,500	shift	two weeks	annually
Pump.....	1,750	shift	monthly	annually
Pump.....	3,500	shift	two weeks	annually
Propellers..	1,800	shift	three months	annually
Fan.....	500	shift	six months	annually
Lineshaft..	Variable		two weeks	annually

By following this schedule the intervals between inspections are longer and the bearings are cooler.

External indications of trouble are noisy cages or peculiar rattles, sometimes heat. A slack motion on reversal of rotation will indicate the necessity for the operator to inspect the bearing. Inspection is always to be accompanied with a careful check-up of adjustment.

Too-frequent and excessive greasing or oiling is as detrimental as not enough. These bearings have hard, close-grain surfaces, which do not wear, and a little lubricant will last a long time.

We have used this schedule for five years, have bearings operating at high speed, 3,500 r.p.m., for over 25,000 hr. and the bearings look as good as new. We have very little trouble and find motor and pump failures less frequent where roller bearings are installed.

W. A. ERION.

Columbus, Ohio.

I DO NOT THINK ball bearings require as much attention as babbitt bearings. We have about 3,000-ft. of lineshaft equipped with roller bearings and have a few babbit bearings on smaller shafts which are lubricated as often as are roller bearings. This, of course, depends upon the load they are handling, the heavier the load, the more often the lubricating.

It is easy to detect a bad working roller bearing. If you hear a click, grind or any sound which comes from the bearing, you know the bearing is either worn, in a cramped position or needs lubrication. Once each year, at the inventory period, we wash out the bearings with gasoline, taking them apart if we have time and men available.

In the matter of babbit bearings, if they run hot and dirty oil comes from them, you can rest assured that something is wrong. Personally, I think roller bearings are much cheaper than babbit bearings. Of course they cost more but over a two-year period roller bearings will prove cheaper, in regard to time and lubrication saved.

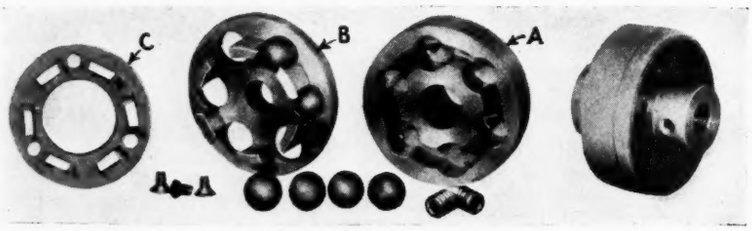
JOHN L. WHITE.

Lima, Ohio.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Coupling With Rubber Balls as Flexible Member



Edmunds flexible coupling using rubber balls as shock-absorbing element

USE OF rubber balls to provide torsional resilience characterizes the Edmunds flexible coupling brought out by the Crocker Wheeler Electric Manufacturing Company, Ampere, N. J. The coupling also takes care of various forms of misalignment and shock.

Referring to the illustration, the flange half *A* has six cylindrical pockets, all parallel to the shaft, and a circular groove in the spaces between the pockets. The other half *B*, the spider, has six projecting lugs between which are placed the rubber balls that absorb the shock.

When the coupling is assembled the balls occupy the pockets in the flange *A* and, as the torque to be transmitted varies, the lugs on the spider half squeeze the balls correspondingly and these provide the resilience needed for shock absorption. With this arrangement all the balls are under compression in either direction of rotation.

The balls may be removed for examination or renewal by first taking off the cover *C*, shown at the left, which covers the holes in the spider half, and then pushing out the balls by means of a rod passed through small holes provided for that purpose. This makes possible the removal of balls without disturbing the position of the machine or either half of the coupling on its shaft.

An additional feature of this coupling is that by removing the rubber balls the motor or other driving mechanism can be disconnected from the load for testing or other purposes. No lubrication is used.

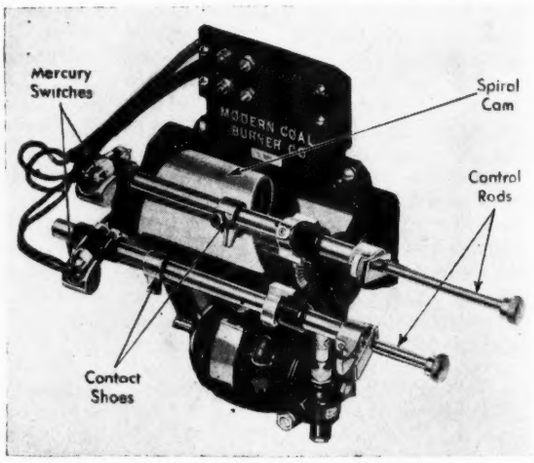
The coupling is made in a range of shaft sizes, from the No. 4 with a $\frac{1}{2}$-in. bore to the No. 31 with a $3\frac{7}{8}$-in. bore. The first will transmit $\frac{1}{8}$ hp. per 100 r.p.m., and the second 35 hp. per 100 r.p.m. It is possible to have a larger bore in the flange half that has the cylindrical pockets.

Coal Feed Regulator for Small Underfeed Stokers

IN THE operation of the small motor-driven underfeed stokers now widely used with heating small industrial boilers one of the difficulties encountered is the proper adjustment of the coal feed to amount of air supplied by the forced-draft fan.

The ideal feeding rate of a stoker is found at the point where the stoker runs almost constantly in meeting the given heating requirements. In actual operation, however, it is necessary to stop the stoker from time to time to prevent the fuel bed from becoming too thick. This is due to the fact that the stoker must operate at a slightly higher rate than is necessary to satisfy the pressurestat or other means of automatic control. The ideal feeding rate is just as little above the requirements of the pressurestat or thermostat as is practicable and unless this adjustment is made the coal is fed at a high rate for a short period and then the stoker is idle for a long period. Regardless of the number of speeds provided by the stoker, it is often found that one speed is too high and the next slower speed too low for a given burning rate.

To overcome this difficulty, the stoker regulator illustrated (designated Feed-O-Meter) has been developed by the Modern Coal Burner Company, 3733 Lincoln Ave., Chicago, Ill. This regulator provides a wide range of feeding rates from clear on to clear off, and the effect is essentially that of continuous firing, because the forced-draft fan, which is independently driven, is not stopped during the off period.



Feed-O-Meter provides a wide range of feeding rates from full off to continuous running

The regulator consists of a fractional-horsepower motor driving a spiral cam through a large gear reduc-

tion so that the cam revolves once in approximately two minutes.

In the path of the revolving cam is one or more contact shoes which operate mercury switches as shown in the illustration. The switches are arranged so that they fall into a closed position whenever the shoes are not in contact with the cam. Although the illustration shows only two of these switches, one to four switches may be used to control one to four stokers independently.

The different settings, "on" and "off," are obtained by moving the control rods, on which the contact shoes are mounted, in or out. This moves the shoe so that it is nearer or farther from the apex of the spiral, which varies the interval from clear off to practically continuous running, with infinite combinations between.

The device is installed in a sheet-metal box (not shown) with the control rods protruding so that they can be operated from the outside. Although developed primarily for controlling the stoker put out by the same manufacturer, the regulator is applicable to any stoker that is driven by a motor and may also be used to control other machinery requiring intermittent operation.

Comparator for Phosphate Determination Employs Colored Glass Standards

IN AN ENDEAVOR to simplify the method of phosphate determination in connection with boiler-water conditioning, the Hagan Corporation, Pittsburgh, Pa., has introduced the phosphate comparator illustrated. In this instrument the process of making the final comparison of the blue color with some standard has been greatly simplified over that generally employed. In place of using a set of blue standards from solutions containing known amounts of phosphate, colored glass standards are employed. This, it is claimed, has so simplified the process of determination and the apparatus itself that speed and accuracy of analysis are now possible in the hands of the boiler operator himself.

To use the instrument, the sample in a small glass cell is treated to develop the color, and this cell is placed in one side of the comparator. In the other side, in a similar cell, is placed another portion of the sample. This compensates for any color that the boiler-water sample may have, since the light passing through the blue glass standard also passes through it. Two beams of light entering the back of the comparator through a white glass plate, passing, one through the treated portion of the sample and the other through the compensating portion and colored glass standards, are brought into juxtaposition by a system of prisms. Because of their juxtaposition, the colors are readily and accurately matched by a boiler operator or one unskilled in chemical laboratory methods.

The comparator is capable of being used not only with the phosphate color disk but with color disks for pH determinations.

Hagan comparator for phosphate determination in connection with boiler water conditioning employs colored glass standards in place of a set of blue standards from solutions containing known amounts of phosphate

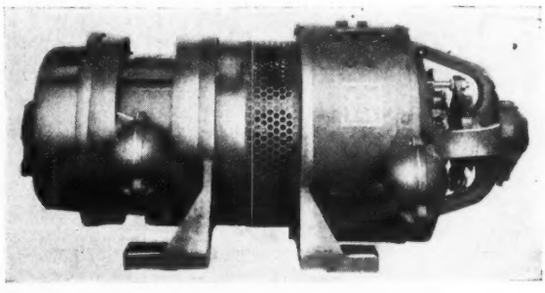
One-Unit Motor-Generator Set

AVAILABLE in capacities from one to five kilowatts, the new line of one-unit motor-generator sets now being put out by the Reliance Electric & Engineering Company, 1088 Ivanhoe Road, Cleveland, Ohio, employs only two bearings, one at each end. In the new line the usual alternating-current motor and direct-current generator are combined in a single unit, with the induction motor rotor and direct-current armature mounted on the same shaft.

This design provides compact construction, requires less space than the two-unit set and simplifies installation. Sets can be furnished for operation in either two- or three-phase circuits on any standard voltage or frequency. They may be obtained with either sleeve or ball bearings.

Improved Electrode for Arc-Welding Stainless Steel

AN IMPROVED ELECTRODE for the arc welding of stainless steel has been recently developed by The Lincoln Electric Company, Cleveland, Ohio, and will be known as the improved "Stainweld A." It is an extruded electrode used with usual polarity of welding current reversed. The coating of the electrode contains no carbon, which eliminates the possibility of the molten weld metal absorbing carbon from the electrode coating during the welding process. It is also said to have an important bearing upon the resistant qualities of the weld, since a slight increase in carbon in the weld permits more rapid corrosion. Welds deposited by this improved electrode are produced in a "shielded arc," which prevents the combination of atmospheric oxygen and nitrogen with the molten weld metal from forming oxides and nitrides in the weld.



Motor and generator combined in a single unit

Electro-Chemical Feeds for Lime Soda and Acid Water-Treating Systems

THE accompanying illustrations show two electro-chemical feeding systems, type B and type D, now being put out by the Permutit Company, 440 Fourth Ave., New York City.

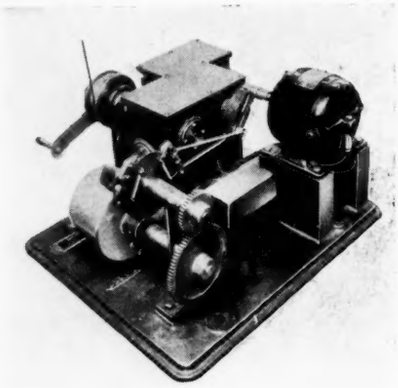


Fig. 1—Control unit used with type B electro-chemical feed

Type B, shown in Figs. 1 and 2, is generally used in connection with lime, soda and similar plants, and type *D*, shown in Figs. 3 and 4, is particularly suitable for installations in which acid is fed to the water. In each system a standard water meter with a cam attached is used to measure the flow of water to the unit and to make the electrical contacts which furnish the impulse to start the motor of the control unit.

In the type *B*, the control unit functions to raise or lower a swing draw-off pipe in the chemical feeding tank and thus regulate the amount of chemical feed to the dilution tank. As shown in Fig. 1 motor cam *B* of the control unit is rotated through a separate pawl and ratchet drive so that its speed can be set as desired. By means of this adjustment the time period of the motor operation following each meter impulse can be controlled by setting the speed of the cam. This setting determines the volume of chemical feed per unit volume of water passing the meter irrespective of the rate of flow of water. Several sets of change gears are supplied with each control unit. By changing the gear ratio the rate of feed can be varied over a wide range, but once the correct gear ratio has been selected ordinary variations in chemical dosage can be obtained by adjusting the throw of the crank.

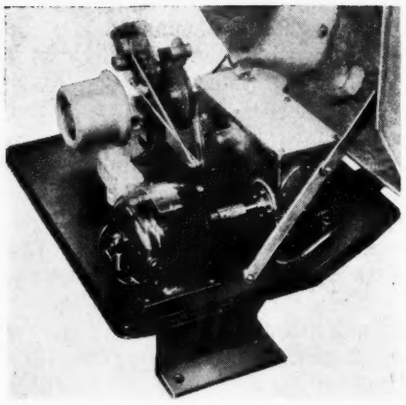


Fig. 4—Control unit used with type D acid feed

In the type *D* unit, generally called "Acid Feed," the same type of meter with contact cam attached is employed to measure the water and control the supply of current to the motor of the control unit. In place of a swing draw-off pipe as used in the type *B* unit, the control motor operates a helical-rotor positive-displacement pump. This pump, by virtue of its design, withdraws at each revolution a definite volume of chemical solution irrespective of the level of chemical in the tank, and since it operates for a definite period of time in each cycle, a definite volume of chemical per cycle is fed to a given volume of water. The chemical is discharged at the top of the helix to a housing from which it flows by gravity to a separate dilution tank.

In both systems signal lamps indicate at all times how the chemical feed is operating. The lamps can be located at any convenient point. Specially designed snap switches are used in the control unit to prevent arcing.

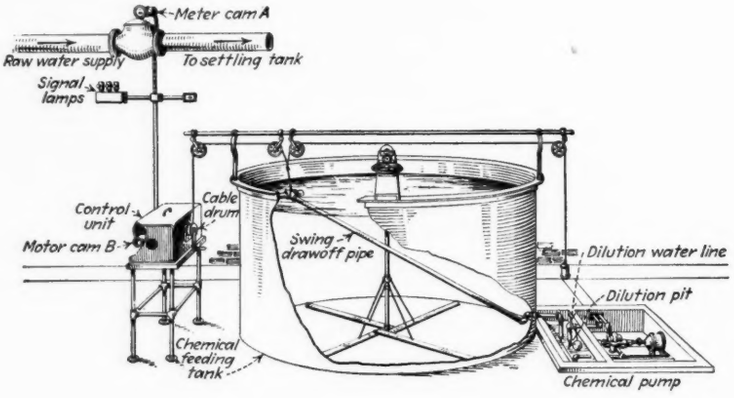
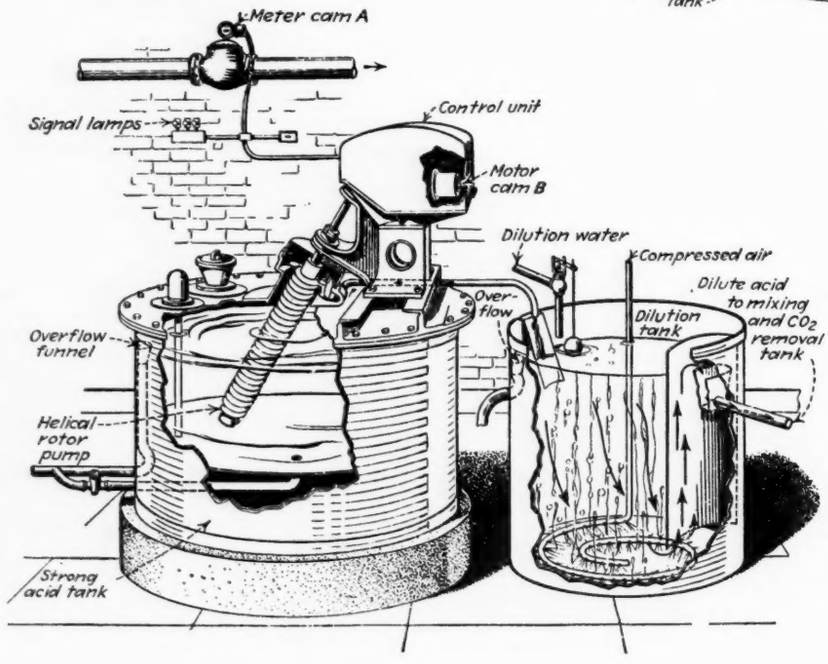


Fig. 2 (Right)—Typical arrangement of type B system

Fig. 3 (Below)—Type D electro-chemical feed with helical rotor proportionating pump



NEWS of the FIELD

Program Announced for A.S.T.M.-A.S.M.E. High-Temperature Symposium in Chicago

Requirements and properties of metals at high and low temperatures to be discussed at two sessions on June 23

THE PROBLEM of providing alloys suitable for high-temperature service in the power, oil, chemical, metallurgical, automotive and ceramic industries will be discussed fully by engineers and metallurgists at the joint symposium on high-temperature engineering to be held by the American Society of Mechanical Engineers and the American Society for Testing Materials at the latter's annual meeting in the Hotel Stevens, Chicago, Ill., on June 23.

Comprising two technical sessions, the symposium will deal with the subject from an engineering point of view. One session will take up the needs of each industry, how far and by what alloys they are met at present, and what needs are as yet unfilled. The second session will be devoted to descriptions of the good and bad properties of the alloys now in use, or ready for use, and will show what the user must do in the design and operation of equipment to make the most of the good qualities and minimize the effects of the poor ones.

The needs of the power industry will be set forth in three papers sponsored by the A.S.M.E. Committee on Central Station Power. These are "Steam Boilers and Superheaters," by H. J. Kerr; "Turbines," by R. C. Allen; and "Valves, Pipes and Fittings," by F. W. Martin. They tell clearly how alloys used in power equipment are effected by temperature under service conditions. An important addition to this session will be three papers by foreign engineers —one by J. H. S. Dickenson and R. W. Bailey of England on "Engineering Trends in the Use of Metals at High Temperatures," a second by Drs. Strauss, Schotty and Schaftmeister of Germany on "Influence of Temperatures on Properties of Heat-Resistant Alloys," and the third by Dr. P. Chevenard of France on "Fundamental Phenomena Governing the Performance of Metals in High-Temperature Service."

At the second session the properties of various alloys now available for high- and low-temperature service will be set forth in papers by eminent metallurgists. These papers include: "High-Temperautre Properties of Copper-Base Alloys," W. B. Price; "Bearing Metals," E. R. Darby; "Creep Data on Wrought Carbon and Low-Alloy Steels," A. B. Spooner and F. B. Foley; "High- and Low-Temperature Properties of Cast Carbon and Low-Alloy Steels," R. A. Bull; "Cast and Malleable Iron Properties at High Temperatures," J. W. Bolton and H. Bornstein; "Nickel and Nickel Alloys," C. A. Crawford and R. Worthington; "High Chromium Steels for Extreme Service Conditions," C. E. MacQuigg; "Effect of Temperature on the Properties of Nitrided Alloy," O. E. Harder; "Low-Temperature Properties of Metals," H. W. Russell; "Thermal Expansion of Metals in Relation to High-Temperature Service," N. L. Mochel; "Thermal Conductivity of Metals in Relation to High-Temperature Service," M. S. Van Dusen.

Although there are nearly 30 papers in the symposium, they will not be read or abstracted in detail at the meeting. Instead, one general summary of the papers on engineering trends and needs will be presented at the first session and one of the papers on metallurgical properties at the second, after which the sessions will be thrown open for general discussion of the subject. All papers are being preprinted and will be available soon from C. L. Warwaick, secretary of the A.S.T.M., 1315 Spruce St., Philadelphia, Pa., so that they may be studied before the meeting.

Railroads Reduce Smoke Nuisance in Hudson County

CONSIDERABLE PROGRESS has been made during the past month in reducing the smoke nuisance from railroads in Jersey City, Hoboken and Weehawken, N. J., according to the monthly report just issued by William G. Christy, smoke abatement engineer for Hudson County. Organization of the Railroad Smoke Association in March placed the railroads on a competitive basis in combating the nuisance, the report states, and resulted in an intensive campaign to discover the reasons for excessive smoke from locomotives. Many of the locomotives were found to have defective parts, and in every instance the work of making repairs and replacements was quickly attended to. Engineers and firemen were also given strict orders on methods of firing their engines in accordance with the regulations issued by the county smoke bureau.

Mr. Christy says he is "confident that railroad smoke abatement is now on the way to very radical improvement without the long years of delay that are often characteristic of movements dealing with railroads."

The report also states that during the month industrial plants continued to exhibit keen interest and intelligent cooperation in the fight on smoke.

Governor Roosevelt Vetoes School Ventilating Bill

GOVERNOR ROOSEVELT vetoed last week the Mastick bill amending the education law of New York State in relation to plans and specifications for the construction of school buildings. This bill would have changed the specifications to read "proper ventilation" in schools instead of the more exact provision in the original law of "at least 30 cu.ft. of pure air every minute per pupil." It also would have struck out the clause relating to "foul air."

Ventilating engineers in the state were opposed to the bill and consider the Governor's veto a substantiation of sound engineering principles.

New Hampshire Would Charge Utilities for Rate Studies

A FAVORABLE REPORT has been filed by the New Hampshire Senate Judiciary Committee on a bill providing that the cost of rate investigations by the Public Service Commission shall be charged back to the utilities involved.

The bill was characterized recently by Governor John G. Winant as "the most important act before the Legislature."

Under its provisions all costs of rate investigations except the salaries of the commissioners would be charged to the utilities up to but not exceeding an amount equal to $\frac{1}{2}$ of 1 per cent of the existing valuation. The costs would be amortized over a period of years.

An amendment was proposed by the committee at the suggestion of Governor Winant to protect the utilities against successive investigations.

THIRTY-NINE CARS FOR ONE UNIT

THREE STRINGS of freight cars, including a total of 39 box cars, gondolas, regular flats and a special flat, were required to move one electric generator from Schenectady to New York on its way to be shipped to the Soviet Union. The generator, the first of five being built at Schenectady, will be installed at the Dnieper River hydro-electric development at Kichkas, in the Ukraine. Rated at 77,500 kva. each, these units are the largest waterwheel-driven generators of any type ever built.

Each generator has a total weight of approximately 1,760,000 lb. The weight of the rotor and shaft is about 980,000 lb. The maximum diameter of the generator is 42 ft. and the overall height 40 ft. 5 in., with 17½ ft. extending above the floor of the plant. Fabricated, welded construction is used, eliminating large castings. The stator is in six sections, with the punchings and windings assembled in each section before shipment; the rotor was dismantled for transportation.

The upper bearing, 16 ft. in diameter, is shown on a special car at the left end of the illustration. The steel shaft, 36 ft. long and 40 in. in diameter, weighing 136,000 lb. with 70-inch end flanges, was moved in a gondola car.

▼ ▼ ▼

Order Steam Units for New Jersey Stations

AN ORDER for the 75,000-kw. single-cylinder steam turbine-generator to be installed as No. 6 unit at the Kearny generating station of the Public Service Electric & Gas Company of New Jersey, was recently placed with the Westinghouse Electric & Manufacturing Company.

Operating at 350 lb. pressure and 750 deg. F. total temperature, the new unit will receive part of its steam from the mercury vapor condensers serving the 20,000-kw. mercury-vapor unit recently ordered from the General Electric Company. The major portion of the steam required to operate to full capacity the new 75,000-kw. Westinghouse turbine, however, will come from the existing boiler equipment installed at the Kearny station.

In addition to the above the Public Service company has also ordered from the Westinghouse company an 18,000-kw., high-pressure, turbine unit for the Burlington generating station. This unit will operate with new boiler equipment on 650 lb. steam pressure and 850 deg. F. total temperature and exhaust into a low-pressure steam header serving three existing Westinghouse 200-lb. turbines. By the addition of this new high-pressure turbine with its boiler equipment and auxiliaries, the Burlington station is being remade into a most economical generating station and will be capable of developing approximately 55,000 kilowatts.

The approximate value of the two orders placed with the Westinghouse company is $1,250,000.

Supreme Court Asked to Review Turbine Case

THERE IS PENDING before the Supreme Court of the United States the case of the De Laval Steam Turbine Company against the United States, which is a petition by the company for a writ of certiorari to review a decision by the United States Court of Claims. The question in the case is whether a construction company which had entered into contracts with various parties to construct marine steel turbines requisitioned by the government, upon cancellation by the government is entitled to any allowance under the statute providing for just compensation on account of the anticipated profits which would have been made if the contracts had been fully performed.

The Department of Justice has filed a brief in this case in which it is stated that on account of the importance of the question and there being no decision by any court touching the issues involved no opposition will be made to the granting of the petition and review of the case by the Supreme Court.

The petitioner manufacturing company made several contracts with different companies in 1917 for the manufacture of turbine equipment and later these contracts were requisitioned by the Fleet Corporation of the United States and cancelled by that corporation after the Armistice. The Court of Claims made an effort to adjust the issues involved but declined to make allowance for anticipated profits from any of the contracts.

National Oil and Gas Power Meeting at Madison in June

TENTATIVE PROGRAM for the fourth National Oil and Gas Power Meeting, to be held at the University of Wisconsin, Madison, from June 23 to 26, has recently been announced by L. H. Morrison, chairman of the program committee of the Oil and Gas Power Division of the American Society of Mechanical Engineers. Seventeen papers will be presentde at the technical sessions, and the usual exhibit of diesel-engine parts and accessories will be held as part of the meeting.

Subjects to be covered in the papers include: "Dispersion of Oil Spray," "A Quiescent Combustion Chamber," "Experiments on the Flow of Air Through Engine Valves," "Observation of European Diesel Developments," "Remarks on European Trends in Diesel Design," "European Report of Diesels for Motor Trucks," "Fuel-Oil Research Committee Report," "Diesel Power Costs," "Development of Double-Acting Diesel," "How to Select a Diesel Engine," "Design of an Automatic Diesel Plant," "Diesel Municipal Light Plants in the Middle West," "Application of Oil Engines to Ship Propulsion," "Light-Alloy Pistons and Rods in High - Speed Industrial Engines," "Diesel Engine and the Public," "Piston-Packing Problems," and "Outstanding Municipal Diesel Power Plant."

Insull Buys Gary Utility From U. S. Steel Corporation

THE INSULL INTERESTS, through the Midland United Company, have acquired the Gary Heat, Light & Water Company, of Gary, Ind., from the United States Steel Corporation, according to a recent announcement of the latter company. Details of the transaction were not made public, but the steel corporation's announcement stated: "In view of the increasing importance and volume of service required in Gary, it is deemed for the best interest of all concerned that the business be placed under the ownership and control of those who are quali-

fied by long and successful experience to give the best service."

The Gary system operates at 25 cycles, and it is understood that consumers objected to the 25-cycle energy supplied. Objections were also raised to the rates charged. Early last year the Gary company settled a dispute of several months standing over the rate schedule. A citizens' committee had threatened to appeal to the Indiana Public Service Commission for lower rates. The company, however, countered with a new schedule which was accepted.

Hold Chemical Industries Show in New York, May 4-9

THE THIRTEENTH EXPOSITION of chemical industries will be held during the week of May 4 at the Grand Central Palace, New York City, and will include exhibits on three floors devoted to the raw materials for the manufacture of chemicals and chemical products, technical products used in the arts and industries, apparatus and equipment, machinery and the finished products of the chemical industries.

Special sections will be devoted to the showing of raw materials from the Southern States, the natural resources of Canada and its provinces, new metals and alloys, laboratory supplies and equipment, materials handling and containers. The machinery and apparatus will vary from laboratory equipment through instruments of precision to equipment for large-scale operations.

The students' course on the fundamentals of chemistry, and chemical engineering will again be under the chairmanship of W. T. Read, dean of the school of chemistry at Rutgers University.

Work Started on Final Stage of Lochaber Project

CONSTRUCTION of the second and final portion of the large hydro-electric project of the British Aluminum Company in the Lochaber district of the Scottish Highlands has just been commenced. This part of the development will take about three years to complete and will include the construction of a large dam in the River Spean, to raise the waters of the river to the same height as Loch Laggan, thus forming a reservoir about ten miles in length. From the Spean dam a tunnel will be driven through the shoulders of the hill for about three miles to a point at the north end of Loch Treig.

Extensions are to be made at the power house and factory erected near the extremity of the Ben Nevis tunnel. In the last stage of the scheme it is proposed to divert flood waters from the River Spey into Loch Laggan. When this and other works are completed it is calculated that it will be possible to generate 120,000 hp. in the power house.

$100,000,000 Power Plan Would Run Turbines Directly on Natural Gas to Use Alberta Waste

RECENT PROPOSALS to solve the waste gas problem of Alberta's oil fields through a $100,000,000 power development has brought assurance from the Alberta Government that no serious obstacle to the project is apparent. If the plans are finally approved by the government, the Hercules Consolidated Mining, Smelting & Power Corporation will proceed with an undertaking in the southern part of the province, whereby waste natural gas from Turner Valley will be utilized for the generation of electricity. Construction of a plant would be commenced within 90 days after the granting of approval and 70,000 hp. would be generated within a year. Officials of the company have stated that it is planned to spend not less than $10,000,000 at the outset and ultimately, within a period of about 15 years, to spend about $100,000,000 on the project.

The plan as roughly outlined is to collect the waste gas in Turner Valley into one pipe line running to the power house where at the high pressure it is available from the wells it would be used to turn specially-designed turbines for the generation of electrical power. The power house would be located at a point probably 30 miles east of Turner Valley and it would not depend alone on gas from Turner Valley but would utilize also gas from other fields. It is understood that the plans include as well the erection of an auxiliary steam-electric plant where the gas, after going through the first set of turbines, would be burned under high-pressure boilers.

The proposal as submitted to the Alberta Government states that the corporation proposes to establish a large plant in the vicinity of the oil field for the purpose of generating electrical energy for commercial sale in the provinces of Manitoba, Saskatchewan, Alberta and British Columbia and also in the border states of the United States. Pipe lines would be run from the oil wells to the generating station and cheap electrical power would be distributed throughout the territory mentioned over high-power transmission lines under control of the corporation or subsidiary companies. The Government of Alberta is asked to pass legislation compelling all oil companies whose gas is escaping and not being put to use, to supply the corporation with such gas at a price to be fixed through a public utilities board. As a consideration for the establishment of such a plant as proposed the government is asked to grant an exclusive franchise for a period of 99 years to the corporation to generate, sell and export the electrical energy. Provision would be made, if desired, for the government to take over the plant on an equitable basis at some time in the future.

A market for the power generated under this plan will be secured through industrialization of southern Alberta.

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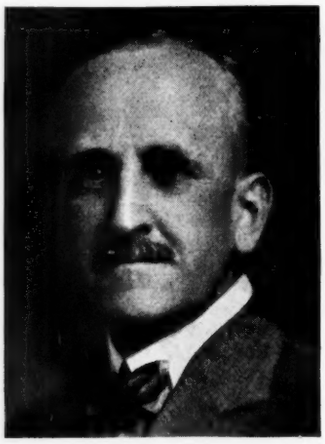
WILBUR SIGNS HOOVER DAM CONTRACT

Harris & Ewing

Secretary Wilbur's signature April 20 on the contract for the construction of Hoover Dam was the final touch needed to start the giant project under way. Those witnessing the signing are Northcutt Ely, executive assistant to the Secretary; W. A. Bechtel, first vice-president of the Six Companies, Inc., which was awarded the contract; Edward J. Harding, managing director of the Association of General Contractors of America; and Miss M. A. Schnurr, assistant to Director of Reclamation Elwood Mead

Prof. Wood of Penn State Killed by Motorcycle

PROF. ARTHUR J. WOOD, head of the department of mechanical engineering at Pennsylvania State College and past president of the American Society of Refrigerating Engineers, was killed by a motorcycle on April 18 near the college grounds. As director of the Engineering Experiment Station at Penn State, he was widely known for his research work in the fields of refrigeration, power development, locomotive operation, and the transmission of heat in insulating and building materials.



Arthur J. Wood

Professor Wood was born in Newark, N. J., on Sept. 3, 1874. He graduated from Stevens Institute of Technology in 1896 as a mechanical engineer and received the degree of Master of Science from Penn State in 1916. From 1896 to 1900 he was associate editor of the *Railroad Gazette*. In 1900 he started his academic career as instructor in mechanical engineering at Worcester Polytechnic Institute, following which he became professor of mechanical and electrical engineering at the University of Delaware. He went to Pennsylvania State College in 1904 as assistant professor of mechanical engineering and was made head of the department and director of the experiment station in 1920.

In 1926 he served as vice-president of the American Society of Refrigerating Engineers and was elected president of the society in 1929. He was a member of the National Research Council, American Society of Mechanical Engineers, and the Society for the Promotion of Engineering Education.

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DANIEL H. DEYOE of the industrial engineering department of the General Electric Company, a director and member of the American Welding Society and a figure for many years identified in electric arc welding activities, died in Schenectady, April 11, at the age of 55. Mr. Deyoe was a graduate of Union College, class of 1898, and joined the General Electric organization in the same year.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Lubrication meeting at Pennsylvania State College, May 22. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 23-26. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual convention at Skytop Lodge, Skytop, Pa. May 25-27. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers. District meeting in Rochester, N. Y., Apr. 29-May 2. Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers. Semi-annual meeting at the New Ocean House, Swampscott, Mass., June 22-26. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Spring meeting at the Athletic Club, Kansas City, Mo., May 6-8. Secretary, David L. Fiske, 37 West 39th St., New York.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 25-26. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R. Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

National Association of Heating and Piping Contractors. Annual convention in Louisville, Ky., May 6-9. Chairman of convention committee, M. J. Chagnard, 419 West Jefferson St., Louisville, Ky.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

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Personals

HERBERT M. SHARP, assistant superintendent of the Charles R. Huntley stations one and two of the Buffalo General Electric Company, has been advanced to superintendent of the stations, succeeding ALEXANDER M. MASON, deceased. Mr. Sharp has had extensive experience in steam power plant engineering both with industrial and utility companies.

CHARLES R. VANNEMAN, formerly chief engineer of the Public Service Commission of New York, has formed a corporation for the general practice of engineering, particularly as it applies to public utilities. The corporation is known as Charles R. Vanneman, Inc., Albany, N. Y. Besides Mr. Vanneman, the officers include NEWELL L. NUSSBAUMER, vice-president, and RAY P. DIEHL, treasurer.

WILLIAM G. PRAED has been appointed radiograph engineer in charge of the recently established commercial X-ray laboratory of the Claud S. Gordon Company in Chicago. Mr. Praed was formerly assistant to the general superintendent of the Link Belt Company's Indianapolis plant.

CLAUDE R. LESTER has been appointed chief of the new Oregon Public Service Commission's engineering department by CHARLES M. THOMAS, commissioner. Mr. Lester had served in this capacity with the old commission.

R. E. J. SUMMERS has resigned as vice-president and contract manager of the H. K. Ferguson Company to become president of Summers Engineers & Constructors, Inc., with offices in New York City and Cleveland, Ohio.

JO C. GUILD, JR., vice-president and general manager of the Tennessee Electric Power Company, was elected president of the Southeastern Division of the National Electric Light Association at the recent annual meeting of that division. Mr. Guild, who has had a wide experience in the construction and operation of hydro-electric plants, is the son of the late Jo C. GUILD, who, together with the late C. E. JAMES, was instrumental in pioneering the development of water power in Tennessee.

JOHN A. WALLS, vice-president and chief engineer of the Pennsylvania Water & Power Company, was recently elected a director of the Consolidated Gas, Electric Light & Power Company of Baltimore.

MARCY L. SPERRY, who has held important positions for some years in companies under Stone & Webster supervision, has been made vice-president in active charge of the Fall River Gas Works Company to succeed C. C. CURTIS, who has been transferred to the Puget Sound Power & Light Company.

Business Notes

BUSCH-SULZER BROS.-DIESEL ENGINE COMPANY, St. Louis, Mo., is planning the construction of a new erecting shop, suitable for testing diesel engines of large sizes up to 25,000 hp., and an extension of its iron foundry with a 75-ton craneway. W. J. Knight & Company, engineers, have been retained to draw plans and supervise the work.

TOLEDO PIPE THREADING MACHINE COMPANY, Toledo, Ohio, announces a prize contest for the best letter of not more than 500 words, submitted before July 10, on the subject "Why Timely Purchase of New Threading and Cutting Pipe Tool Equipment Is Sound Business Practice." Forty-five prizes will be awarded. Full details of the contest may be had by writing the company.

TIMKEN STEEL & TUBE COMPANY, Canton, Ohio, announces the appointment of Walter H. Wiewel as sales manager to succeed A. J. Sanford, who resigned. Mr. Wiewel has been associated with the company for several years as manager of steel sales in New York City. He will now make his headquarters at Canton.

STRONG-SCOTT MANUFACTURING COMPANY, Minneapolis, Minn., has appointed the Hammitt-Crozier Company, Kansas City, Mo., as its district representative in Kansas, Nebraska and western Missouri.

J. D. DRYBURGH & COMPANY, Los Angeles, Calif., have recently been made sole agents in America for the Swedish "Nohab" two-cycle, solid-injection diesel engine.

THE MERIAM COMPANY, Cleveland, Ohio, announces the appointment of Mayer & Oswald, 332 South LaSalle St., Chicago, Ill., as its sales representative in the Chicago territory.

BYRON JACKSON COMPANY, San Francisco, Calif., reports that net profit for the year 1930 amounted to $358,067, or $1.03 per share, as compared with $1,043,962, or $3.04 per share, for 1929. The report states, "There were no reductions in shop wages or minor salary wages (during 1930), but all executive salaries have been reduced."

ALLEGHENY STEEL COMPANY, Brackenridge, Pa., announces that in order to lessen confusion prevalent in the alloy field, it will henceforth use the name Allegheny in connection with all its products. The name Allegheny Metal, designating the 18 and 8 alloy, will remain unchanged, but alloys hitherto known as Ascoloy will be known as Allegheny 33, 44, etc.

HENRY VALVE COMPANY, Chicago, Ill., announces the appointment of the A. P. Miller Supply Company, 332 West 21st St., New York City, as its Eastern distributor.

How's Business?

THE SLIGHT spring stimulus seems to have spent its force by the latter part of March and business has been backsliding since. Our index has steadily declined during the past five weeks till, at *77.7* per cent of normal, it is nearby back to the December low. Security markets have closely followed suit and commodity prices continue their relentless movement toward inconceivably low levels. Seasonal building improvement seems to be weakening again, and carloadings still show little more than seasonal recovery. Hope of reversal of the downward drift of steel production by May persists under expectation of larger structural and pipe-line demand, but marked increase in automotive requirements becomes doubtful. It now appears likely that first quarter business improvement was only a bump on the bottom and not the definitive beginning of recovery. — *The Business Week*, April 29.

Trade Catalogs

CORK PIPE COVERING—Prices and specifications for installation are contained in the new cork pipe-covering price book just issued by L. Mundet & Son, 461 Eighth Ave., New York City.

COMPRESSORS — Sullivan Machinery Company, 400 North Michigan Ave., Chicago, Ill., has recently issued three new bulletins: No. 83-V on railroad type portable compressors, No. 71-J on air-made wells and air-lifting pumps, and No. 100-A1 on safety lighting cable for portable lights.

RAILINGS AND FENCES—Full information on pipe railings, fences, and special construction for power and industrial plants, buildings and outdoor walks, is contained in the new 76-page, illustrated catalog just issued by the Vulcan Rail & Construction Company, Grand St. & Garrison Ave., Maspeth, N. Y.

LUBRICANTS—General catalog No. 24 has recently been issued by the United States Graphite Company, Saginaw, Mich., covering in condensed form the products of the company, which include graphites, greases, lubricants, paints, polishes, pipe-joint compound, motor and generator brushes.

COAL HANDLING—An illustrated description of a cable power scraper for the storage of coal and other bulk materials is contained in a new publication of the Atlas Conveyor Company, 20 South 15th St., Philadelphia, Pa.

FEED-WATER REGULATION—Northern Equipment Company, Erie, Pa., has just issued a new bulletin on the Copes system of boiler feed control. Among the products described and illustrated are feed-water regulators, regulating valves, pressure control, differential valve and pump governor.

AIR FILTERS—An illustrated folder on air filters for all purposes has recently been issued by the Staynew Filter Corporation, Rochester, N. Y.

PIPE THREADING—Catalog L, just issued by the Toledo Pipe Threading Machine Company, 1425-45 Summit St., Toledo, Ohio, covers the company's full line of pipe tools. Among the products described and illustrated are pipe threading devices, pipe cutters, reamers, vises, portable work benches, boring tool, power drives and power pipe machines.

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Fuel Prices

FUEL OIL

Boston—April 20, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.9c. per gal.

New York—April 23, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

Philadelphia—April 16, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl

Pittsburgh—April 15, f.o.b. local refinery, fuel oil, 30@34 deg., 2.875c.@3c. per gal.; 36@40 deg., 2.875c.@3c. per gal.

Cincinnati — April 14, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—April 19, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 46.25c. per bbl.; 22@24 deg., 51.25c. per bbl.; 24@26 deg., 52.5c. per bbl.; 26@28 deg., 62.5c. per bbl.; 28@30 deg., 76.25c. per bbl.

St. Louis—April 14, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.245 per bbl., or 42 gal.; 26@28 deg., $1.37 per bbl.; 28@30 deg., $1.495 per bbl.; 30@32 deg., $1.595 per bbl.; 32@36 deg., gas oil, 3.151c. per gal.; 38@40 deg., distillate, 4.026c. per gal.

Dallas—April 18, f.o.b. local refinery 24@26 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, h. gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.50 @ 2.00
Smokeless, slack	Chicago	1.25 @ 1.35
Harlan, Ky., slack	Chicago	1.00 @ 1.10
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.65 @ 1.75
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	.90 @ 1.25
W. Ky., slack	Louisville	.70 @ .85
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.75 @ 2.00
Smokeless, slack	Cincinnati	1.00 @ 1.30
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.85 @ 1.25

Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.25
Barley	New York	1.40

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Fairfield—City plans an election May 23 to vote $42,500 for waterworks improvements, including well, deep well turbine pump, tank on tower, mains, etc. A. M. Jensen, 68 Post St., San Francisco, is engineer.

Calif., Gridley—City rejected bids of Mar. 9 for a Diesel engine to replace present inadequate steam plant standby service. Installation indefinitely postponed.

Conn., Bristol—Connecticut Light & Power Co., Riverside Ave., is receiving bids for the construction of a 60 x 60 ft. steam power plant including steam line, oil tanks, etc. Estimated cost $175,000. H. A. Hayden, 175 North Main St., is engineer.

Conn., New London — Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of a Diesel engine laboratory at Naval Submarine Base, to Thomas Perrone, Inc., 1026 Main St., Hartford.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., awarded masonry contract for foundation for a 7 story, 62 x 85 ft. electric distribution station at 1034-38 North Western Ave., to Person Construction Co., 100 North La Salle St. Estimated cost $70,000.

Ind., Jasper — City will soon award contract for the construction of a power plant, including equipment. Estimated cost $40,000. C. Brossman, Chamber of Commerce, Indianapolis, is engineer.

Ia., Cedar Rapids—City will receive bids until April 30 for sewage pumping plant including two 8,000 g.p.m., one 5,000 g.p.m. pumps and one 200 g.p.m. sump pump. H. R. Green Co., 208-10 Bever Bldg., is engineer.

La., New Orleans—Sewerage & Water Board, will receive bids until April 30, for the construction of a 1 story, 30 x 330 ft. pumping station including setting pump, etc.

Mass., Chelsea—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until April 29, for the construction of a refrigerating and ice making plant including motor driven compressors, condenser, pumps, blower, etc. at Naval Hospital here.

Mass., East Springfield—United Electric Light Co., 73 State St., Springfield, is receiving bids for the construction of a transformer substation including tower and electrical power equipment on Page Blvd. Estimated cost $1,000,000. Private plans.

Mass., Walpole—Town is having plans prepared for a sewage treatment plant, including pumping equipment, etc. Estimated cost $140,000. E. Worthington, 4 Pearl St., Dedham, is consulting engineer.

Mass., Worcester—Worcester County Commission, E. W. Glidden, Court House, will receive bids until May 8, for the construction of a group of buildings for sanitorium including hospital, nurses home, service building and power plant at Huntington Farm. Estimated cost $1,000,000. Frost, Chamberlain & Edwards, 390 Main St., are architects.

Mich., Baraga — Baraga County Light & Power Co., awarded contract for the construction of a hydro-electric plant on Sturgeon River, near here, to Price Bros. Co., Findlay St., Dayton, O.; generators to Allis-Chalmers Co., West Allis St., Milwaukee, Wis., and turbines and governors to S. Morgan-Smith Co., Hartley and Lincoln Sts., York, Pa.

Mich., St. Joseph—City, I. D. Wagner, Clk., will receive bids until May 11, for waterworks system including pumping and filtration plant, suction well, pump room, etc. H. G. Crow, City Mgr.

Minn., Redwood Falls—City will receive bids until May 5, for waterworks improvements including pump house, pumping equipment, etc. L. P. Wolff, 903 Globe Bldg., St. Paul, is engineer.

Miss., Jackson—State Hospital Removal Commission, will receive bids until May 4, for the construction of a group of buildings including boilers for power and heating plant. N. W. Overstreet, is architect.

Mo., Leeds—Mountain Ice Co., c/o City Ice & Fuel Co., W. J. Sinek, V. Pres., 33 South Clark St., Chicago, Ill., awarded contract for a 60 x 120 ft. ice plant, storage building, icing platform, 2,500 ft. long and 13 ft. wide on Missouri Pacific R.R. tracks west of Blue River to R. S. Blome Co., First National Bank Bldg., Chicago, Ill. Ice making machinery to Ball Ice Machine Co., 126 Chouteau Ave., St. Louis, $350,000.

Mo., St. Louis — West End Ice Co., 120 Chouteau Ave., awarded contract for the construction of a 75 x 80 ft. ice plant at 3945 Easton Ave. to M. R. Rosenmeyer, 1548 South Vandeventer St. Equipment contract let to Ball Ice Machine Co., 120 Chouteau Ave.

N. H., Exeter—Exeter Hospital, Prospect Hill, awarded contract for the construction of a heating plant and laundry, to I. W. Brown, Northampton. Estimated cost $40,000.

N. J., Hackensack — Bd. of Chosen Freeholders, J. M. Harkness, Clk., Court House, will receive bids about June 1 for the construction of a 6 story administration building, including steam heating, and ventilation systems, boilers, elevators, etc., at Main and Hudson Sts. Estimated cost $1,200,000. E. L. Tilton and W. F. Schwanewide, 420 Lexington Ave., New York, are architects.

N. J., Kearny—Public Service Gas & Electric Co., subsidiary of Public Service Corp. of New Jersey, Terminal Bldg., Newark, awarded contract for equipment for 75,000 kw. steam turbine generator unit here, also 18,000 kw. turbine unit at Burlington, to Westinghouse Electric & Mfg. Co., 150 Broadway, New York, N. Y.

N. J., Long Branch—E. C. Hazard Hospital, 81 Washington St., is having sketches made for the construction of a 10 story hospital, including steam heating system, etc., at Washington Ave. and Dewey St. Estimated cost $1,000,000. P. C. Reilly, 111 5th Ave., New York, N. Y., is probable architect.

N. Y., Brooklyn—Brooklyn & Queens Transportation Co., 385 Flatbush Ext., plans the construction of a 40 x 70 ft. power sub-station at St. Paul's Court and Ocean Ave. Estimated cost $45,000. H. J. Kolb, 385 Flatbush Ext., is architect.

N. Y., Watertown — Beebe Island Corp., G. Seymour, Pres., c/o Knowlton Bros. Paper Co., 213 Factory St., will soon award contract for the construction of a power plant, 10,000 hp. capacity. Estimated cost $600,000 to $700,000.

R. I., Newport—Bureau of Yards & Docks, Navy Dept., will soon award contract for the construction of a central power plant at Naval Training Station here. Private plans.

Tex., Burnet—Emery, Peck & Rockwood Development Co., 208 South La Salle St., Chicago, and Scarborough Bldg., Austin, awarded contract for the construction of dam on the Colorado River in connection with Hamilton hydro-electric project to Fegels Construction Co. Ltd., 711 Wesley Temple, Minneapolis, Minn., also power transmission line from Marble Falls to site of dam to L. E. Myers Co., Allen Bldg., Dallas. Estimated cost $6,000,000.

Tex., Eagle Pass — Central Power & Light Co., National Bank of Commerce Bldg., San Antonio, will soon receive bids for the construction of a 40 x 100 ft. power plant, including 750 hp. power unit here. Estimated cost $75,000. L. F. Harza Engineering Co., 20 North Wacker Dr., Chicago, Ill., is engineer.

Tex., El Paso—E. Held, 2209 Tremont St., will build a 75 ton ice plant. Estimated cost $80,000. Private plans. Work will be done by day labor. Equipment purchased.

Tex., Galveston—City is having plans prepared for the construction of a municipal electric plant including power plant, boiler plant equipment, turbine room equipment and distribution system. Estimated cost $1,000,000. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., are engineers.

Tex., Laredo—W. Epstein, is receiving bids for the construction of a 10 story office building including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. here. Estimated cost $500,000. W. H. Anderson and G. Trout, Laredo, are architects. Matthews & Kenan, Milam Bldg., San Antonio, are engineers. L. D. Royer, is mechanical engineer.

Utah, Salt Lake City—City is having preliminary plans prepared for improvements to waterworks including pumping plant, etc. Estimated cost $2,000,000. H. Jessen, City and County Bldg., is engineer.

Va., Richmond—Carmeal, Johnston & Wright, Electric Bldg., Archts., are receiving bids for the construction of a 40 x 111 ft. power plant for St. Josephs Orphanage now under construction at Hollybrook near here.

Ont., Toronto — City, plans replacement of eight boilers in John St. waterworks pumping station. Estimated cost $203,000. R. C. Harris, City Hall, is engineer.

Equipment Wanted

Boiler—Crawfordsville, Ind.—City will receive bids until May 4 for a 950 hp. water tube boiler with superheater and soot blower, forced draft chain and grate stoker for proposed power plant. $60,000. Bids for erection of the power plant will be received May 18.

Boilers, Pumps, Generators, etc. — Detroit, Mich.—Bd. of Water Commissioners, will receive bids until May 19 for 100 hp. boilers, two 5,000 kw. main turbo generators, three 500 kw. auxiliary turbo generators and all associated auxiliary equipment for power plant piping systems, Springwells Station.

Condenser — Pasadena, Calif. — City, B. Chamberlain, Clk., will receive bids until May 15 for furnishing and installing a surface condenser with 2 unequaled circulating pumps and appurtenances.

Generator—Stillwater, Okla.—Oklahoma A. & M. College, plans a 350 kw. steam turbine generator unit for power purposes. Estimated cost $30,000.

Generators, Exciters, Pump and Blower — Vernon, Calif.—City, T. J. Furlong, Clk., will receive bids until May 6 for Diesel engine generators, exciters, circulating water pump and air blower for new power plant.

Motors—Boston, Mass.—Gerard Electric Co., 101 Pearl St., plans to purchase electric motors, gas engines, etc.

Pump—Ogdensburg, N. Y.—Dept. of Mental Hygiene, State Office Bldg., Albany, will receive bids until May 6 for a water pump, etc., at St. Lawrence State Hospital here.

Pumping Unit—Pittsburgh, Pa.—City, E. G. Lang, Dir. of Public Works, will receive bids until May 5 for motor driven pumping unit and accessories for Herron Hill pumping station.

Pumping Unit—Sioux Falls, S. D.—Bd. of Commissioners, W. C. Leyse, Auditor, will receive bids until May 4 for a 1,500 g.p.m. electrically driven deep well vertical turbine pumping unit, 60 ft. head, 220 v., 3 ph., 60 cycle for waterworks.

Transformer and Electric Meters—Anaheim, Calif.—City, E. S. Merritt, Clk., will receive bids until May 12 for two electric transformers, also electric meters.

Industrial Projects

Calif., Emeryville — Paraffine Co., Inc., 475 Brannan St., San Francisco, awarded contract for the construction of a 1 story linoleum factory here, to MacDonald & Kahn, Financial Center Bldg., San Francisco. Estimated cost $50,000.

Mass., Boston—Eastern Smelting & Refining Co., 109 West Brookline St., plans reconstruction of factory recently destroyed by fire. Estimated cost $40,000. Private plans.

Miss., Jackson — Mississippi Match Co., Natchez, awarded contract for the construction of a factory including two warehouses and five outbuildings to W. G. Wetmore Construction Co., Jackson. Estimated cost $125,000.

N. J., Butler—American Hard Rubber Co., Boonton Ave., awarded contract for addition and alterations to factory to Walter Kidde & Co., 140 Cedar St., New York, N. Y. Estimated cost $150,000.

N. Y., Brooklyn—C. H. Liebfried, 112 Dobbins St. (light manufacturing), is having preliminary plans prepared for a 1 story, 70 x 100 ft. factory at Quernsey St. and Norman Ave. Estimated cost including equipment $40,000. J. A. Napoli, 151-01 32nd Ave., Flushing, is architect.

O., Cleveland—Gulf Refining Co., Frick Annex, Pittsburgh, Pa., plans the construction of an oil storage building including boiler house, pump house, machine shop, etc., at 220-250 West Jefferson St., here. E. N. Gibson, 3026 Hotel Cleveland, Cleveland, is engineer (temporarily).

O., Cleveland — Ohio Carbon Co., J. E. Schunck, Secy. and Treas, 12508 Berea Rd., is having preliminary plans prepared for a 1 story addition to factory. Estimated cost $40,000. George S. Rider Co., Marshall Bldg., are architects and engineers.

O., Zanesville—Zane Casting Co., will soon receive bids for the construction of a 1 story factory including foundry, machine shop, etc. at Park and Amelia Sts. Estimated cost $50,000. Private plans.

Pa., Erie — Erie Sand & Gravel Co., R. W. Potter, Pres., awarded contract for foundation for improvements to plant including tunnels, bins, conveyors and sand washing equipment at West Front and Sassafras Sts. to E. E. Austin & Son, 20th and Reed Sts.

Tex., San Antonio—Sealy Mattress Co., N. Deehan, 1002 South Medina St., plans the construction of a plant. Estimated cost $275,000. Private plans. Machinery and equipment will be required.

Tex., Texas City—Republic Oil Refining Co., Houston, has work under way on the construction of an oil refinery here. Estimated cost $500,000. Private plans. Work being done by owner's forces.

Ont., Fergus—Beatty Bros., plans two additional units to plant, 50 x 150 ft. each for the manufacture of agricultural and household implements and equipment. Estimated cost $100,000. Private plans.